Exchange Rate Exposure at the Firm and Industry Level

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Previous work on the exposure of firms to exchange rate risk has primarily focused on U.S. firms and, surprisingly, found stock returns were not significantly affected by exchange-rate fluctuations. The equity market premium for exposure to currency risk was also found to be insignificant. In this paper we examine the relation between Japanese stock returns and unanticipated exchange-rate changes for 1,079 firms traded on the Tokyo stock exchange over the 1975–1995 period. Second, we investigate whether exchange-rate risk is priced in the Japanese equity market using both unconditional and conditional multifactor asset pricing testing procedures. We find a significant relation between contemporaneous stock returns and unanticipated yen fluctuations. The exposure effect on multinationals and high-exporting firms, however, is found to be greater in comparison to low-exporting and domestic firms. Lagged-exchange rate changes on firm value are found to be statistically insignificant implying that investors are able to assess the impact of exchange-rate changes on firm value with no significant delay. The industry level analysis corroborates the cross-sectional findings for Japanese firms in that they are sensitive to contemporaneous unexpected exchange-rate fluctuations. The co-movement between stock returns and changes in the foreign value of the yen is found to be positively associated with the degree of the firm's foreign economic involvement and inversely related to its size and debt to asset ratio. Asset pricing tests show that currency risk is priced. We find corroborating evidence in support of the view that currency exposure is time varying. Our results indicate that the foreign exchange-rate risk premium is a significant component of Japanese stock returns. The combined evidence from the currency exposure and asset pricing analyses, suggests that currency risk is priced and, therefoe, has implications for corporate and portfolio managers.

I. INTRODUCTION

It is a widely held view that exchange-rate movements should affect corporate expected cash flows, and hence stock returns, by causing changes in the home currency value of foreign currency denominated revenues (costs) and the terms of competition for multinationals and firms with international activities (importers and exporters).[1] In general, however, if purchasing power parity is violated,

[1] See, among others, Amihud and Levich (1994).

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exposure to exchange rate risk is not limited to firms with direct foreign trade activities. The growing emphasis on exchange risk management, the extensive use of foreign currency derivatives and other hedging instruments by corporations to protect their foreign currency denominated cash flows from unexpected exchange-rate movements, implies that the market value of the firm is sensitive to exchange rate uncertainty (see, for example, Nance, Smith and Smithson (1993), Bodnar, Hayt, Marston and Smithson (1995), and Bodnar, Hayt and Marston (1996)).

This paper investigates the importance of exchange rate fluctuations on firm value. This is a central issue to several international financial management problems. If currency risk is not diversified away, currency exposure should yield a risk premium in an equilibrium asset market. However, the empirical evidence has produced mixed results and most studies have relied on U. S. data.[2] For instance, Choi and Prasad (1995) find significant exchange rate exposure while several studies (Jorion (1990), Amihud (1994), Bodnar and Gentry (1993), Bartov and Bodnar (1994)) report that neither U.S. multinationals, nor the largest U.S. exporters nor U.S. manufacturing industries, at large, are significantly affected by contemporaneous exchange rate movements. One possible explanation for these surprising results is the fact that corporations make extensive use of foreign currency hedging instruments that may have reduced the ability of these studies to identify a significant contemporaneous correlation between stock returns and exchange-rate fluctuations.[3] Other effects may also increase the identification problem. Bartov and Bodnar (1994) attribute the failure of previous studies to detect the valuation effects of exchange-rate movements to sample selection procedures and investors' errors in modeling and estimating the relationship between contemporaneous exchange-rate fluctuations and changes in firm performance.

Currency pricing tests (Jorion (1991)), using Chen, Roll and Ross' (1986) multifactor model, show that exchange rate risk is not priced in the stock market. This evidence on the pricing of exchange rate risk for U.S. firms seems to be in sharp contrast with the findings of recent studies that show exchange rate risk being priced in the aggregate stock market level. These findings may be due to the fact that such empirical tests rely on the maintained assumption of a constant foreign exchange risk premium, despite the increasing evidence that the foreign exchange market is characterized by nonzero conditional risk premia.[4,5] Doukas, Hall and Lang (1999), however, show that

[2] An exception is Levi (1994).

[3] Smith and Stulz (1985) discuss why firms actively manage foreign currency risk. Allayannis and Ofek (2001) report that the use of currency derivatives has significant risk-reduction effects on the foreign currency exposure of U. S. corporations.

[4] See Fama (1984), Korajczyk (1985), and Giovannini and Jorion (1989) for evidence in support of the view that the foreign exchange market is characterized by nonzero conditional risk premia.

[5] More recent empirical studies (Allayannis and Weston (2001), Dominguez and Tesar (2001a, 2001b), and Williamson (2001)) document a significant relationship between exchange rate changes and stock returns.

currency risk is priced when asset pricing tests are designed to account for time-varying risk premia in response to changes in macroeconomic conditions. A limitation of their pricing testing procedure rests with the fact that second moments are fully discounted. Consistent with the international capital asset pricing model (ICAPM)[6], Dumas and Solnik (1995), and DeSantis and Gerard (1998) show that time-varying exchange rate risks are priced in international asset markets.[7,8] However, these conditional tests were conducted at the national stock market level for Germany, Japan, the United Kingdom and the United States. These diverse empirical findings raise the following question: why is currency exposure found in the aggregate stock market returns but not in the firm and industry returns?

There is a compelling need to examine corporate currency exposure and whether currency risk is priced, under the assumption that the price of risk varies over time, outside the U.S environment. There is an even greater need to address these questions today because earlier studies have failed to jointly examine the issues of corporate exposure to exchange-rate movements and the pricing of exchange-rate risk in capital markets. In this study, we argue that the foreign currency exposure of the firm must be verified in the context of capital markets through conditional asset pricing tests that allow the currency risk premium to vary over time. Hence, currency pricing tests represent an integral element of our corporate currency exposure investigation.[9] Namely, this approach is expected to enhance our understanding about the nature of currency risk and its impact on firm value by the asset pricing restriction.

We argue that the use of a conditional testing framework similar to the intertemporal asset pricing methodology used in aggregate stock market tests for the pricing of exchange-rate risk, that allows risk premia to change through time in response to predetermined information, should permit us to use the appropriate measure of currency exposure and re-examine accurately the relation between exchange-rate changes and equity value. Hence, the asset pricing restriction is expected to improve the measurement of currency exposure. Consistent with Dumas and Solnik (1995) and DeSantis and Gerard (1998), our conditional tests rely on the assumption that the foreign exchange market is characterized by nonzero time-varying risk premia. These tests, avoid the limitations of previous studies that fail to account for investors' changing currency risk perceptions and information that is available to them at any given point in time.[10]

[6] See Solnik (1974), Sercu (1980), Stulz (1981), and Adler and Dumas (1983).

[7] Hamao (1998), however, shows that exchange rate risk is not recognized by investors in the stock market of Japan over the 1975–1984 period.

[8] The risk is measured by the covariance of each security with exchange rates.

[9] See also Doukas *et al.* (1999) among others.

[10] The recent international finance literature, summarized by Giovannini and Jorion (1989), suggests that unconditional expected returns from forward market speculation are generally rather small.

Prior research has focused mainly on studying the currency exposure of U.S. firms and it is not clear how these empirical results relate to different countries. Without testing the robustness of these findings outside the U.S. environment, it is hard to determine whether these empirical regularities are merely a spurious correlation that may not be confirmed in other countries. In addition, the empirical design of previous studies may be subject to sample biases as they have exclusively focused only on multinational or large exporting firms and data snooping problems associated with the selection of firms that are included in the CRSP and Compustat databases. Less is known about other markets and especially the Japanese market. He and Ng (1998) examine the currency exposures of a limited sample of Japanese firms, loosely defined as multinationals, over a short time-horizon that spans the 1979–1993 period only. Surprisingly, they report that currency exposure is predominantly positive throughout the 1979–1993 period for about 25% of the firms in their sample. Such uniform currency exposure could be linked to the selection period. Further, it is rather difficult to infer about the currency exposure of Japanese firms over a longer period and for firms with different foreign involvement characteristics. The He and Ng (1998) study suffers from the same data, empirical design, and testing limitations as most of its U.S. predecessor studies do.

Unlike previous studies, in this paper we examine both the currency exposure and pricing of currency risk for a large sample of Japanese firms covering 25 Japanese industries based on two-digit standard-industrial classification codes. Employing a sample of 1,079 Japanese firms, this study is motivated by (i) the inconsistent results reported in earlier studies based on U.S. firms; (ii) the need to examine the robustness of previous findings across countries and especially for Japan, one of the major exporting nations among industrialized countries; and (iii) the fact that a sample of Japanese firms is expected to reduce the noise in the analysis because Japanese firms are more likely to be susceptible to unexpected exchange-rate movements due to their heavy involvement in international trade activities.[11]

However, our study faces several empirical challenges. First, unanticipated exchange-rate changes may affect domestic firms that compete against Japanese (foreign) importing (exporting) corporations. Also, some firms may be influenced by unexpected exchange-rate movements because they either import inputs of production or use domestically available inputs whose prices are determined in international markets. Furthermore, domestic firms can be affected by unexpected exchange-rate changes through changes on aggregate demand and therefore their inclusion into the analysis permits

[11] Bartov and Bodnar(1994) argue that failure of previous studies to control for firms' linkages to international conditions may have been the reason why they could not document a significant relation between exchange rate changes and stock returns.

us to examine whether they are indirectly exposed to exchange-rate movements. For these reasons, the analysis of currency exposure effects and pricing of currency risk for Japanese corporations and industries is overdue given (i) Japan's economic reliance on foreign markets; (ii) Japanese firms' dependence on foreign inputs of production; and (iii) the recent evidence that shows exchange-rate risk to be priced at the aggregate stock market level in Japan.[12]

In this paper, we examine the following four questions concerning the effects of unexpected exchange rate movements: (i) Are Japanese multinational, high-exporting, low-exporting and domestic (i.e., non-exporting) corporations exposed to exchange-rate volatility?; (ii) Is the corporate exposure to exchange rate movements uniform across firms and industries in Japan?; (iii) What are the determinants of exchange rate exposure?; and (iv) Is currency risk priced in the Japanese equity market?. We also address the issue of a contemporaneous versus non-contemporaneous relation between unexpected exchange-rate changes and firm value since Amihud (1994) and Bartov and Bodnar (1994) argue that current stock price adjustments are influenced only by lagged exchange-rate movements.

The rest of the paper is organized as follows. Section II defines exposure to unanticipated exchange-rate movements and describes an intertemporal asset pricing methodology to re-examine the relation between exchange-rate changes and equity returns. Section III describes the data and discusses the results based on conditional tests on the relationship between exchange rate exposure and Japanese stock returns. The effects of non-contemporaneous exchange-rate exposure are also examined. In Section IV, the sources of firm's exposure to exchange rate changes are analyzed. Section V provides the unconditional and conditional pricing of currency risk tests and reports the results. Section VI contains some concluding remarks.

II. EXCHANGE-RATE EXPOSURES OF JAPANESE FIRMS AND INDUSTRIES

Foreign Currency Exposure Effects

Foreign exchange exposure has been defined (Dumas (1978) and Adler and Dumas (1980, 1984)) as the sensitivity of the market value of the firm to unanticipated exchange rate movements. Therefore, exchange-rate effects are dependent upon the firm's (i) foreign exposure (i.e., determined by its operating

[12] Hamao (1988) and Brown and Otsuki (1990) find mixed results with respect to the pricing of the exchange risk factor in Japan using different testing procedures and sample periods. Bodnar and Gentry (1993), using industry portfolios for the United States, Japan and Canada find exchange risk exposure to be positive (negative) for exporting (importing) industries.

revenue, cost exposure and its operating cash flow margin)[13], and (ii) use of foreign currency hedging instruments. Dumas (1978) also argues that currency exposure contains an "operational" element that accounts for the firm's responsiveness to exchange-rate movements that may lessen the exchange-rate effect on the firm's market value. For instance, multinational corporations (MNCs) with the ability to shift production from one country to another to protect themselves from the unexpected fluctuations of the exchange rates would tend to reduce the adverse valuation effects of their currency exposures. In general, it is expected that firms with relatively large percentage of foreign revenues or costs are more likely to be exposed to exchange-rate movements than firms with smaller involvement in foreign operations or trade and therefore these firms would tend to use more foreign currency hedging instruments as has been documented in recent studies (see, for instance, Bodnar, Hayt, and Marston (1996), and Allayannis and Ofek (2001))

Since currency exposure measures the firm's net exchange-rate exposure (i.e., firm's financial and operational post-hedging exchange-rate sensitivity), firms with low foreign international involvement are more likely to have low foreign currency exposure and consequently be less affected by exchange-rate changes. Especially, if they adjust their balance sheet exposures by means of various currency hedging instruments. Such hedging transactions, if known to market participants, will tend to lessen the relation between stock prices and unexpected exchange-rate movements. Domestic firms may also be affected by unexpected exchange-rate changes through changes on aggregate demand or on the cost of imported inputs; domestic firms that compete against importing firms will also be exposed to exchange-rate movements. In the context of Japan, however, the presence of restrictions on foreign imports, often

[13] A reduced form of equation (3) that isolates the exchange-rate effect from the non-exchange-rate effects can be written as

$$\frac{\Delta V}{V} = \beta_1 \frac{\Delta S}{S} \tag{1}$$

where $\Delta V/V$ is the change in the value of the firm, β_1 is the exposure coefficient and the $\Delta S/S$ is the unanticipated exchange-rate change. The exposure coefficient can be expressed as

$$\beta_1 = \beta_R(R/OCF) - \beta_C(C/OCF) \tag{2}$$

or

$$\beta_1 = \beta_R(R/OCF) - \beta_C(R/OCF - 1) \tag{3}$$

since the firm's base currency operating cash flows (OCF) is equal to the difference between the firm's base currency operating revenues (R) and its base currency operating costs (C), equation (1) can be written as

$$\Delta V/V = [\beta_R(R/OCF) - \beta_C(R/OCF - 1)]\Delta S/S \tag{4}$$

where β_R is the operating revenue exposure, β_C is the operating cost exposure and the term R/OCF is the inverse of the firm's cash flow margin. From equation (4) it is clear that the higher the firm's international involvement the higher its currency exposure for a given exchange-rate. Apparently, equation (4) also shows that exchange-rate risk is dependent on exposure and exchange-rate volatility.

reported in the financial press (see, for example, Business Week, July 28, 1997), will tend to reduce domestic firms' exposure. This might explain why domestic firms are less likely to hedge their foreign currency risk than export-oriented firms. However, the use of currency hedging derivatives will depend upon managers' familiarity with derivative products and the existence of substantial fixed costs required to develop and manage a currency risk hedging program. We expect that these two additional factors will make the use of a currency hedging program less attractive to smaller firms and firms with lower foreign currency exposures.

Clearly, the valuation effects of the appreciation and depreciation of the yen against the dollar or other currencies are likely to be asymmetrical and non-uniform across firms due to differences in real operating structures, use of hedging instruments, methods of financing, and foreign economic linkages. Furthermore, a firm's foreign currency exposure is likely to change over time and consequently difficult to detect over short-horizon intervals. Hence, the weak relation between contemporaneous changes in exchange rates and firm value recorded in previous studies could be attributed to their focus on U.S. multinationals and the largest U.S. exporting firms that are likely to make extensive use of foreign currency hedging instruments, consequently difficult to identify their foreign currency exposure. It is interesting to note that prior research has mainly focused on the early years of the floating exchange-rate regime. Therefore, the relation between firm value and the changes in the dollar before 1973 and a few years after may have been difficult to characterize which may be the reason for the limited success of previous studies in identifying a significant correlation between simultaneous stock returns and dollar fluctuations.

Unlike previous studies, we consider not only multinational and high exporting firms in our analysis but also firms with different degrees of linkages to the international environment, such as low-exporting and domestic firms. Using a diverse sample of firms allows us to compare our findings to the U.S. results and examine whether corporate currency exposure is associated with the international trade characteristics of the firm. In addition, the use of a long sample period should reduce the difficulty of economic agents to assess the valuation effects of unanticipated exchange-rate changes and examine whether foreign currency exposure varies over time. Finally, the use of econometric tests that (i) do account for the endogenous nature of exchange rates and stock market returns, and (ii) rely on the assumption of a time-varying currency risk premium may shed additional light why previous research has failed to detect evidence in support of exchange-rate exposure.

Foreign Currency Exposure Tests: A Conditional Framework

Exchange-rate exposure refers to the sensitivity of a firm's market value to unanticipated exchange-rate movements. Consequently, economic exposure to exchange-rate movements is estimated by the regression coefficient describing the systematic relation between the market value of the firm and the unexpected exchange-rate change accounting for market movements (Adler and Dumas (1980, 1984)). However, the association between endogenous variables, such as stock market returns and exchange rates may just reveal the simultaneous influence of monetary factors or exogenous shocks on exchange rates and stock returns. That is, if exchange rates and stock returns are generated by a set of common macroeconomic factors, stock prices should be responsive to unanticipated exchange-rate changes, after controlling for the influence of common macroeconomic factors. The common macroeconomic factors reflect the persistent impact of business conditions on the foreign exchange and stock markets. To the extent that economic agents form expectations about exchange-rate and stock market movements based on information that is available to them at the beginning of each period, exchange rates will adjust in response to changing economic conditions and their changing currency risk perceptions. This implies that exchange rate and stock market changes must be expressed as functions of a set of macroeconomic variables that determine the way expected exchange-rates and market returns vary systematically through time. As a result, currency exposure tests should rely on unexpected currency and market movements that are orthogonal to each other and to investors' conditioning information in any given interval of time.

Orthogonalization between the foreign exchange market and the stock market is achieved through the estimation of the residual market factor that is not explained by the set of predetermined macro variables, including the unexpected exchange rate change (Brown and Otsuki (1993, 1994)). This is also motivated by the widely-held view that foreign exchange market movements are more likely to influence the stock market, rather than being influenced by stock market changes. Investors' ex ante conditioning information can be expressed in terms of instrumental variables. Therefore, the unexpected components of the exchange-rate and market changes are obtained from the following regressions[14]

$$\mathrm{R_{st}} = \phi_{0s} + \sum_{j=1}^{7} \phi_{js}\, \mathrm{IV_{jt-1}} + \sum_{i=1}^{2} \beta_{is}\, \mathrm{R_{it-1}} + \varepsilon_{st} \tag{1}$$

$$\mathrm{R_{mt}} = \phi_{0m} + \sum_{j=1}^{7} \phi_{jm}\, \mathrm{IV_{jt-1}} + \sum_{i=1}^{2} \beta_{im}\, \mathrm{R_{it-1}} + \beta_{sm}\, \hat{\varepsilon}_{st-1} + \varepsilon_{mt} \tag{2}$$

where $\mathrm{R_{st}}$ is the rate of change in the Japanese yen/U.S. dollar exchange rate (BXR) or the rate of change in the trade-weighted exchange rate (TWXR), ϕ_j s are the slope coefficients of the lagged instrumental variables ($\mathrm{IV_j}$): IP, industrial production; UI, unexpected inflation; UTS, term structure

[14] Mark (1995) has shown that exchange rates are predictable by macroeconomic factors over the long horizon. Hence, our measure of exchange-rate changes is conditioned on predetermined information that is allowed to influence change rates.

spread between Japanese long-term and short-term government bond rates; MS, monthly money supply changes; UJS, the US-Japan short-term bill rates spread; XM, trade balance; and the dependent variable, R_{st-1} in (1) and $R_{mt-1,}$ in (2), respectively. R_{it-1} represents the Fama and French (1996) financial variables: value minus growth and small minus large return variables, R_{mt} is the market rate of return, β_{im}'s measure the sensitivities to the financial factors, and ε_{st-1} is the residual Japanese currency return, and ε_t are the random error terms.

Since the empirical literature does not specify the choice of instrumental variables, in any empirical work of this kind, the choice of which variables to include is bound to be somewhat arbitrary. Our choice of instrumental variables was guided by the variables used in previous studies (see, for example, Hamao (1988), and Brown and Otsuki (1993) who find evidence that the macroeconomic variables identified by Chen, Roll and Ross (1986) for the United States have some validity in Japan).

Unlike others' treatment of exchange rate and market movements, our specification implies that agents form expectations about exchange-rate and stock market movements and therefore they are not entirely unanticipated.[15] Hence, the residual components of equation (1) and (2) are used in estimating the currency exposure coefficient, accounting for market movements, of Japanese firms from the time series regression

$$R_{it} = \beta_{0i} + \beta_{1i}\,\hat{\varepsilon}_{st} + \beta_{2i}\,\hat{\varepsilon}_{mt} + \sum_{j=1}^{7} \rho_{jp}\,IV_{jt} + \varepsilon_{it} \tag{3}$$

where R_{it} is the rate of return on the ith firm's (portfolio's) common stock, ε_{st} and ε_{mt} are the residual (unexpected) currency and market returns, respectively, obtained from regressions (1) and (2). The use of the residual currency factor in our analysis is also motivated by Mark's (1995) recent evidence which shows that exchange rates are predictable by such macroeconomic factors over the long horizon. Our exchange-rate exposure tests, at the firm and industry level, are in line with the recent conditional framework used in aggregate stock market tests for the pricing of exchange-rate risk (see Dumas and Solnik (1995) and DeSantis and Gerard (1998)) in the sense that the residual exchange-rate variable accounts for the impact of changing business conditions and investors' changing perceptions about exchange-rate risk over time.

While we control for market movements, another specification advantage of our currency exposure regression (3) is that the market rate of return is treated as an exogenous variable. The use of the residual market factor, then, avoids any bias due to factor correlations and maintains the validity of conventional statistical inference procedures. This may be another reason why previous

[15] Jorion (1990), for instance, uses exchange rate and market returns by implicitly assuming that both changes in stock prices and exchange rates are fully unanticipated.

studies have failed to document exchange-rate exposure for U.S. firms. However, the use of the orthogonalized market factor in (3) tends to reduce the standard error of the coefficient of the residual market factor while increasing that of the exchange rate coefficient (Murphy and Topel (1985)). Hence, evidence of foreign currency exposure would imply that the firm's actual exchange-rate exposure is higher than its estimated exposure. It must be noted here that an alternative specification of regression (3) could include R_{mt} as an independent variable to account for any possible omitted information that may be ignored in its current version. However, empirical results by including the R_{mt} variable in regression (3), not reported here, do not differ significantly from the reported results.

The sensitivity of stock returns to unanticipated exchange-rate movements is measured by the coefficient β_{1i}. If there is no systematic relationship between unanticipated exchange-rate changes and stock returns, the null hypothesis that we test is that the regression coefficient, β_{1i} in (3) receives a zero value. Because firms with higher international involvement are likely to have greater net operating cash flow exposure, it is also hypothesized that they are likely to have greater currency exposure. We estimate equation (3) to investigate whether exchange-rate fluctuations do influence stock returns, using the generalized method of moments (GMM) of Hansen (1982) and the variance-covariance matrix of estimates, computed as suggested by White (1980).

Non-Contemporaneous Foreign Currency Exposure Tests

Previous research (Amihud (1994) and Bartov and Bodnar (1994)) provides evidence consistent with the view that investors require time to assess the complex relationship between exchange-rate changes and firm value. The validity of the lagged-response hypothesis is tested using the following regression

$$R_{it} = \beta_{0i} + \sum_{j=0}^{n} \beta_{1j}\,\hat{\varepsilon}_{st-j} + \beta_{2i}\,\hat{\varepsilon}_{mt} + \sum_{j=1}^{7} \rho_{jp}\,IV_{jt} + \eta_{it} \tag{4}$$

The proponents of lagged-response hypothesis imply that the limited success of previous currency exposure is attributed to investors' systematic errors in the estimation of the relation between exchange-rate movements and stock returns. It is argued that this mispricing is related to the short history of floating exchange rates, the lack of transparency in financial reporting, and the time required by investors to analyze the complex relationship between exchange-rate movements and firm performance. If investors, then, have difficulty characterizing the relation between firm value and yen fluctuations, current stock price adjustments should be influenced by lagged yen movements. To control for investors' unfamiliarity with the functioning of the early period of the floating exchange-rate system and the influence of several official exchange-rate interventions culminating with the exchange-rate arrangements of the Plaza Accord, our analysis is conducted during the pre- and post-1985 period starting January 1975.

III. EMPIRICAL RESULTS

Data Description

We use monthly stock returns (inclusive of dividends) for 1,079 Japanese firms traded on the Tokyo Stock Exchange over the 1975–1995 period. Returns data were obtained from Worldscope (1996), Datastream, and the Pacific Basin Capital Markets (PACAP) Database.[16] Worldscope is also used to determine the firm's primary industry code, market value, and percent of foreign to total sales. The sample is divided into four groups based first on the multinational status of the firm and then on size of its foreign sales. Initially, the *Directory of Multinationals* (Stopford, 1992) is used to identify the multinational status of firms in the sample. Following this Directory, firms are classified as multinationals (MNCs) when they meet the following criteria: (i) firms must have a minimum of 25% of the voting equity of manufacturing or mining companies in at least three foreign countries; (ii) firms must have a minimum of 5% of consolidated sales or assets attributable to foreign investments; and (iii) firms must have a minimum of yen 7.8 billion in sales generated by foreign production operations. Based on these criteria sixty-two (62) firms from the original sample were classified as MNCs with complete stock return and dividend information.[17]

We sort the remaining non-MNC firms into three samples according to their foreign to total sales ratios. The second sample consists of 260 firms with reported foreign sales to total sales in excess of 20% (i.e., high-exporting firms).[18] The third sample is composed of 281 firms with reported foreign to total sales in excess of 0%, but less than 20% (i.e., low-exporting firms). The last sample consists of 476 domestic firms that report no foreign sales. The use of pure domestic firms in the analysis permits us to examine whether such firms are indirectly exposed to unexpected exchange rate volatility (i.e., through changes on aggregate demand, or on the cost of imported inputs or competition by importing firms). Furthermore, the inclusion of firms with no direct linkages to international conditions (i.e., non-exporting firms) is motivated by the argument (Bartov and Bodnar (1994)) that the failure of previous studies to find significant exchange-rate exposures is due to their poor sample selection procedures

[16] Worldscope is a database distributed by Compaq Disclosure and is updated annually. Datastream is an on-line database distributed by Datastream International and is updated daily. The PACAP Database is distributed by the University of Rhode Island.

[17] This classification is unlikely to bias the as the number of multinational firms has not changed dramatically over the sample period.

[18] Jorion (1990) and Amihud (1994) consider only U.S. multinational firms with reported foreign operations and large U.S. exporting firms, respectively.

employed. The non-exporting type of firm, then, allows us to test this hypothesis. This selection procedure, undoubtedly, yields a sample of firms that (i) contains firms that are not uniformly involved in the international environment, and (ii) are unlikely to hedge their foreign currency exposures homogeneously.

A broad cross-section of industries is represented in the sample as the 1,079 firms span twenty-five different two-digit SIC industries. To group the 1,079 firms into 25 industry portfolios, we use the two-digit SIC code. This industry classification permits to examine whether the exchange-rate exposure patterns are industry-specific and compare our results to previous studies (Jorion (1990) and Bodnar, and Gentry (1993)).

The Fama and French (1996) financial variables, defined as the monthly return spread between a portfolio of Japanese value stocks (i.e., high book-to-market) and a portfolio of Japanese growth stocks (i.e., low book-to-market), and the monthly return spread between a portfolio of Japanese small-capitalization stocks and a portfolio of Japanese large-capitalization stocks were obtained from Independence International Advisors Inc. (IIA). IIA creates value and growth indexes for a number of markets, ranking stocks by their book-to-market ratio. IIA selects the highest book-to-price stocks one-by-one from the top of the list of stocks tracked in each country including Japan until half of the capitalization of each market has been accumulated. These stocks, then, become the constituents of the value index and the remaining stocks become the growth index. This implies that when the performance of value and growth index series is compared, the two investment strategies have equal liquidity characteristics and therefore are equally viable for large institutional investors. The division is performed every January, based on data available at year-end. Each index is estimated based on the companies that are in the Morgan Stanley comprehensive data base, as of the rebalance date. The monthly return for each index (value or growth) is computed by taking a weighted average of total returns (price change plus dividends) on the underlying stocks, using outstanding total market capitalization (price per share times number of shares) as weights. Large-capitalization and small-capitalization return series are created in a similar fashion. However, stocks are ranked by their capitalization and the market is split 70/30. The large-capitalization index encompasses 70% of the total market capitalization while the small-capitalization index covers the bottom 30%. These index series are market-capitalization weighted. The procedure used by IIA in creating these indexes is similar to the one used by Lakonishok, Shleifer and Vishny (1994), and Fama and French (1996).

End-of-month exchange rate for the Japanese yen against the U.S. dollar (bilateral exchange rate-BXR) and a real, moving, trade-weighted exchange rate (multilateral exchange rate-TWXR) published by the Bank of England are obtained from Datastream. This latter exchange-rate index is measured in yen per unit of foreign currencies (seventeen) in period t. The method of estimation and relative weights used are similar to those the International Monetary Fund (IMF) uses to estimate its Multilateral Exchange Rate

Model (MERM) exchange-rate index. An increase in the index represents a depreciation of the Japanese yen. The data for the macroeconomic (instrumental) variables are obtained from the International Financial Statistics (IFS). The instrumental variables are: IP, the Industrial Production growth series, constructed as the logarithm of price relatives of the seasonally adjusted index of industrial production reported by the IMF; UI, the Unexpected Inflation series, estimated by subtracting the expected inflation at month $t-1$ from the realized inflation (CPI) rate during month t; UTS, the Term Structure series, constructed from the difference between Japanese long-term government bond series and short-term bonds; MS, the Money Supply series, is the monthly change in the Japanese money supply; UJS, the U.S.-Japan Interest Rate Spread, is the monthly return difference between U.S. and Japanese short-term bill rates; and XM, the Trade Balance series, is the monthly logarithmic difference between exports and imports.[19] The market rate of return, R_{mt}, is the value-weighted index of all firms included in the Nikkei 225 index.

Firm-Specific Exchange-Rate Exposure Effects

We estimate regression (3) using bilateral and trade-weighted exchange-rate changes. Table I presents the average exposure coefficients for the 1,079 Japanese companies classified into four different groups based on their involvement in international operations and trade activities. Panel A reports results from estimating equations (1) and (2). The results show that the U.S.-Japanese interest rate spread is the only variable that has a significant coefficient. Generally, these results are somewhat different from those reported by Hamao (1998) over the period of January 1975 to December 1984, and Brown and Otsuki (1993) for the period March 1981 through the end of June 1992 in that they find no significant individual coefficients. This difference may be attributed to the inclusion of the Fama-French variables in our tests, although their individual significance is low. The hypothesis that all coefficients are jointly zero is marginally rejected, at the 18% level of significance, indicating that exchange-rate movements are determined by economic fundamentals. This is an interesting result because it suggests that short-horizon exchange-rates changes are not fully dominated by noise as it is generally believed. Consistent with the findings of Mark (1995), the evidence supports the view that long-horizon changes in exchange rates contain an economically significant component. However, it is evident from the low R-squared values (.1141 and .1052 for the bilateral and multilateral exchange-rate regressions, respectively) that only a very small fraction of exchange-rate movements is predictable during the short-horizon. It is noteworthy, that the overall fit of these regressions, as measured by the R-squared, is greater than the finess of those reported by Dumas and

[19] The expected rate of inflation is estimated as in Chen, Roll and Ross (1986).

Table 1: Average Currency Exposure of Japanese Firms

This table reports the average currency (β_{1i}'s) and market (β_{2i}'s) coefficients from the following model,

$$R_{it} = \beta_{0i} + \beta_{1i} R_{st} + \beta_{2i} R_{mt} + \varepsilon_{it}$$

where R_{it} is the rate of return on the ith firm's common stock, R_{st} is the orthogonalized rate of change in the month-end spot rate of the Japanese yen/US dollar bilateral (BXR) exchange rate (or the rate of change in the month-end spot rate of the Japanese trade-weighted (TWXR) exchange rate) and R_{mt} is the orthogonalized market rate of return. The orthogonalized currency and market rates of return were obtained from the following models

$$R_{st} = \phi_{0s} + \sum_{j=1}^{7} \phi_{js} IV_{jt-1} + \sum_{i=1}^{2} \beta_{im} R_{it-1} + \varepsilon_{st}$$

$$R_{mt} = \phi_{0m} + \sum_{j=1}^{7} \phi_{jm} IV_{jt-1} + \sum_{i=1}^{2} \beta_{im} R_{it-1} + \beta_{sm} \hat{\varepsilon}_{st-1} + \varepsilon_{mt}$$

where R_{st} is the rate of change in the month-end spot rate of the Japanese yen/US dollar bilateral (BXR) exchange rate (or the rate of change in the Japanese trade-weighted (TWXR) exchange rate), R_{mt} is the log of the value-weighted stock market return based on the Nikkei 225 index, the ϕ's are the slope coefficients of the instrumental variables (IV) where (IP) is the lagged industrial production growth series which is constructed as the log of the price relatives of seasonally adjusted Japanese industrial production as reported by the IMF; (UI) is the lag of the unanticipated inflation series which is estimated by subtracting the estimated inflation at month $t-1$ from the realized inflation rate during month t; (UTS) is the lag of the term structure series which is constructed from the difference between the Japanese long term bond series and short term loans; (MS) is the lagged money supply series which reflects the monthly change in the Japanese seasonally adjusted money supply; (UJS) is the lag of the US-Japanese interest rate spread which is the monthly return difference between US and Japanese short term bill rates; (XM) is the lag of the trade balance series, estimated as the monthly logarithmic difference between exports and imports, and the lagged dependent variable. The coefficients β_i give sensitivities to the common macro-factors, R_{it-1} represents a set of common factors such as the monthly return spread between a portfolio of Japanese value stocks (high book-to-market) and a portfolio of Japanese growth stocks (low book-to-market), the monthly return difference between a portfolio of Japanese small cap stocks and a portfolio of Japanese large cap stocks, and $\hat{e}_{st}$ is the estimated residual currency factor.

Note: Sample I is composed of firms identified as multinationals in *The Directory of Multinational Enterprises*; Sample II is composed of firms with reported foreign sales to total sales in excess of 20%; Sample III is composed of firms with reported foreign sales to total sales in excess of 0%, but less than 20%; and Sample IV is composed of firms with no reported foreign sales to total sales.

Panel A reports the coefficients (ϕ's and β's) from the estimation equations. Panel B reports the slope coefficients of both the currency and market terms, chi square, and R^2 statistics. Panel C reports the percentage of significant positive (N^+) and negative (N^-) currency exposure coefficients, at both the 5% and 10% level of significance. Panel D reports the currency exposure coefficients over different periods. N = the number of firms in each sample. * denotes significance at the 10% level, ** denotes significance at the 5% level and *** denotes significance at the 1% level. Chi-square statistics test the hypothesis that the β_1's are jointly equal to zero across firms within each sample.

Panel A1: Risk factors – bilateral (BXR) exchange rate (1975–1995)

Risk Factor	ϕ_0	ϕ_{IP-1}	ϕ_{UI-1}	ϕ_{UTS-1}	ϕ_{MS-1}	ϕ_{UJS-1}	ϕ_{EX-1}	ϕ_i	β_{vg-1}	β_{sl-1}	β_{fs-1}	R^2 (χ^2)
Value – growth	.0108	–.1079	.0005	–.0016	.0172	–.0001	–.0001	.0550				.1143
	(.933)	(–.704)	(.307)	(–.526)	(.498)	(–.019)	(–1.05)	(.815)				(27.14)
Large – small	–.0144	.2539	–.0016	.0021	–.0411	.0001	.0001	.0924				.1368
	(–1.28)	(1.68)*	(–1.06)	(.819)	(–1.22)	(.157)	(1.17)	(1.37)				
Currency	.0001	–.0029	.0005	–.0026	.0152	.0018	–.0001	.0369	.0993	–.0108		.1041
	(.010)	(–.018)	(.317)	(–.950)	(.421)	(1.97)**	(–1.07)	(.534)	(1.25)	(–.136)		
Market	.0074	.3694	.0002	–.0015	–.0525	.0011	.0001	–.0258	.0001	.1296	–.1023	.1304
	(.399)	(1.49)	(.082)	(–.371)	(–.942)	(.773)	(.072)	(–.365)	(.001)	(1.05)	(–.953)	

Panel A2: Risk factors – multilateral (TWXR) exchange rate (1978–1995)

Risk Factor	ϕ_0	ϕ_{IP-1}	ϕ_{UI-1}	ϕ_{UTS-1}	ϕ_{MS-1}	ϕ_{UJS-1}	ϕ_{EX-1}	ϕ_i	β_{vg-1}	β_{sl-1}	β_{f-1s}	R^2
Value – growth	.0136	.0119	.0021	–.0055	.0031	.0010	–.0001	–.0084				.1004
	(1.12)	(.071)	(1.17)	(–1.51)	(.090)	(.766)	(–.884)	(–.114)				
Large – small	–.0161	–.0118	–.0025	.0057	–.0032	–.0009	.0001	.0339				.1065
	(–1.30)	(–.070)	(–1.41)	(1.57)	(–.090)	(–.673)	(.846)	(.463)				
Currency	.0037	–.0175	.0018	–.0050	.0123	.0033	–.0001	.0213	.0728	–.0084		.1052
	(.282)	(–.096)	(.936)	(–1.26)	(.315)	(2.27)**	(–.806)	(.281)	(.802)	(–.095)		
Market	.0104	.3501	.0012	–.0055	–.0459	.0024	.0001	–.0210	–.0036	.1003	–.1204	.1335
	(.515)	(1.27)	(.417)	(–.903)	(–.775)	(1.09)	(.160)	(–.266)	(–.026)	(.746)	(–1.03)	

Table 1: *Continued*
Panel B: Contemporaneous currency exposure coefficients.

Bilateral (BXR) Exchange Rate					Multilateral (TWXR) Exchange Rate[1]				
Type of Firm	β_1	β_2	χ^2	R^2	Type of Firm	β_1	β_2	χ^2	R^2
All Firms N = 1079					All Firms N = 1079				
Jan 75–Sep 85	−.355**	.976***	2.81*	.3937	Jan 78–Sep 85	−.632*	1.23***	2.93*	.3803
Oct 85–Dec 95	.467**	.947**	3.42**	.1764	Oct 85–Dec 95	.862**	.902**	3.86**	.1823
Jan 75–Dec 95	.068	.487*	.864	.1570	Jan 78–Dec 95	.143	.516*	1.04	.1611
MNCS N = 62					MNCS N = 62				
Jan 75–Sep 85	−.093	1.29***	1.41	.3182	Jan 78–Sep 85	−.232	1.41***	2.11	.2933
Oct 85–Dec 95	.452**	.828**	11.24***	.2710	Oct 85–Dec 95	1.64**	.531*	10.04***	.2045
Jan 75–Dec 95	.307*	.926**	3.12*	.1653	Jan 78–Dec 95	.921*	.611*	2.86*	.1642
High Exporters N = 260					High Exporters N = 260				
Jan 75–Sep 85	−.448*	1.10***	4.03*	.3470	Jan 78–Sep 85	−.156*	1.21***	2.39	.2700
Oct 85–Dec 95	.230*	.815**	3.91**	.2528	Oct 85–Dec 95	1.33**	.606**	4.04**	.1911
Jan 75–Dec 95	.121*	1.46**	4.12**	.1477	Jan 78–Dec 95	.241	.411*	1.32	.1010
Low Exporters N = 281					Low Exporters N = 281				
Jan 75–Sep 85	−.176*	.795**	2.84*	.4698	Jan 78–Sep 85	−1.83**	.941***	2.81*	.4211
Oct 85–Dec 95	.284*	.521**	3.02*	.1823	Oct 85–Dec 95	1.04*	.683**	1.41	.2022
Jan 75–Dec 95	.207	.561**	1.84	.1029	Jan 78–Dec 95	.321	.566*	1.69	.1103
Domestic Firms N = 476					Domestic Firms N = 476				
Jan 75–Sep 85	−.119*	.693***	3.23*	.3437	Jan 78–Sep 85	−.202	.823***	1.21	.3632
Oct 85–Dec 95	.121	.513*	2.01	.0871	Oct 85–Dec 95	.601*	.513**	2.41	.1086
Jan 75–Dec 95	.075	.291*	1.21	.1022	Jan 78–Dec 95	.112	.332*	.864	.0942

[1] Multilateral exchange rate series begins January 1978.
Critical values of χ^2, df = 1: @10% = 2.706; @5% = 3.841; @1% = 6.635.

Panel C: Percentage of significant positive (N^+) and negative (N^-) contemporaneous currency exposure coefficients.

	Bilateral (BXR) Exchange Rate					Multilateral (TWXR) Exchange Rate[1]			
Type of Firm	BXR N^+@5%	BXR N^-@5%	BXR N^+@10%	BXR N^-@10%	Type of Firm	TWXR N^+@5%	TWXR N^-@5%	TWXR N^+@10%	TWXR N^-@10%
All Firms					All Firms				
N = 1079					N = 1079				
Jan 75–Sep 85	12(.01)	101(.09)	58(.05)	201(.19)	Jan 75–Sep 85	12(.01)	101(.09)	64(.06)	204(.19)
Oct 85–Dec 95	133(.12)	44(.04)	202(.19)	70(.06)	Oct 85–Dec 95	136(.13)	46(.04)	206(.19)	71(.07)
Jan 75–Dec 95	97(.09)	57(.05	143(.13)	86(.08)	Jan 78–Dec 95	97(.09)	55(.05)	145(.13)	85(.08)
MNCS					MNCS				
N = 62					N = 62				
Jan 75–Sep 85	0(0)	4(.06)	4(.06)	15(.24)	Jan 78–Sep 85	0(0))	5(.08)	4(.06)	16(.26)
Oct 85–Dec 95	20(.32)	0(0)	25(.40)	0(0)	Oct 85–Dec 95	21(.34)	0(0)	26(.42)	0(0)
Jan 75–Dec 95	12(.19)	1(.02)	16(.26)	1(.02)	Jan 78–Dec 95	12(.19)	1(.02)	16(.26)	1(.02)
High Exporters					High Exporters				
N = 260					N = 260				
Jan 75–Sep 85	0(0)	22(.08)	21(.08)	42(.16)	Jan 78–Sep 85	0(0)	20(.08)	21(.08)	40(.15)
Oct 85–Dec 95	58(.22)	11(.04)	86(.33)	12(.05)	Oct 85–Dec 95	58(.22)	12(.05)	87(.33)	13(.05)
Jan 75–Dec 95	45(.17)	12(.05)	49(.31)	15(.06)	Jan 78–Dec 95	45(.17)	12(.05)	50(.19)	14(.05)
Low Exporters					Low Exporters				
N = 281					N = 281				
Jan 75–Sep 85	7(.02)	32(.11)	19(.07)	67(.24)	Jan 78–Sep 85	6(.02)	33(.12)	22(.08)	69(.25)
Oct 85–Dec 95	33(.12)	6(.02)	47(.17)	9(.03)	Oct 85–Dec 89	34(.12)	7(.02)	48(.17)	10(.04)
Jan 75–Dec 95	20(.07)	10(.04)	32(.11)	16(.06)	Jan 78–Dec 95	18(.06)	10(.04)	30(.11)	16(.06)
Domestic Firms					Domestic Firms				
N = 476					N = 476				
Jan 75–Sep 85	5(.01)	43(.09)	14(.03)	77(.16)	Jan 78–Sep 85	6(.01)	43(.09)	17(.04)	79(.17)
Oct 85–Dec 95	22(.05)	27(.06)	44(.09)	49(.10)	Oct 85–Dec 95	23(.05)	27(.06)	45(.09)	48(.10)
Jan 75–Dec 95	20(.04)	34(.07)	46(.10)	54(.11)	Jan 78–Dec 95	22(.05)	32(.07)	49(.10)	54(.11)

Table 1: *Continued*

Panel D1: Contemporaneous currency exposure coefficients over different periods.

	Bilateral (BXR) Exchange Rate						
	Pre-Plaza Accord	Post-Plaza Accord					
Type of Firm	Jan 75– Sep 85	Oct 85– Dec 90	Oct 85– Dec 91	Oct 85– Dec 92	Oct 85– Dec 93	Oct 85– Dec 94	Oct 85– Dec 95
All Firms N = 1079	–.155*	.301*	.296*	.342*	.221*	.341**	.467**
MNCs N = 62	–.093	.682**	.694**	.584**	.503**	.493**	.452**
High Exporters N = 260	–.448*	.622**	.611**	.423**	.312*	.362**	.330*
Low Exporters N = 281	–.176*	–.162	–.042	.083	.241*	.262*	.284*
Domestic Firms N = 476	–.119*	.023	.162	.242	.163	.219	.121

Panel D2: Contemporaneous currency exposure coefficients over different periods.

	Multilateral (TWXR) Exchange Rate						
	Pre-Plaza Accord	Post-Plaza Accord					
Type of Firm	Jan 75– Sep 85	Oct 85– Dec 90	Oct 85– Dec 91	Oct 85– Dec 92	Oct 85– Dec 93	Oct 85– Dec 94	Oct 85– Dec 95
All Firms N = 1079	–.632*	.525*	.612*	.544	.622*	.703**	.862**
MNCs N = 62	–.233	3.82***	2.93**	2.66**	2.41**	1.93**	1.64**
High Exporters N = 260	–.156*	2.61**	2.82**	1.84*	1.76*	2.01**	1.33**
Low Exporters N = 281	–1.83**	–.886	.066	.143	.243	.461*	1.04*
Domestic Firms N = 476	–.202	.086	–.113	.346	.412	.555*	.601*

Solnik (1995), attesting to the quality of the instruments used in this study. This suggests that the bulk of actual exchange-rate movements is driven by unanticipated exchange-rate changes. This further implies that unanticipated exchange-rate changes (i.e., residuals) should have the same sign as actual exchange-rate changes. The results show that the average sign of the exchange-rate residuals is similar with the sign of actual exchange-rate changes over the two sub-periods examined. For the first period (January1975–September1985) 84% of the residuals are negative while for the second period (October1985–December1995) 92% of the residuals are positive and consistent with the direction in actual exchange-rate changes.

The residuals from these regressions represent the unexpected exchange rate (ε_{st}) and market (ε_{mt}) changes used in estimating regression (3) which defines our currency exposure analysis. These results, as shown in Panel B, suggest that there is significant correlation between the change in the yen and the performance of Japanese firms. These findings hold for both bilateral and multilateral exchange rates. The evidence indicates that Japanese firms are sensitive to exchange rate changes and, as shown by the chi-square values, the hypothesis that exchange-rate exposure is zero is rejected. More specifically, exchange-rate exposure is found to vary across time and type of firm. During the January 1975 – September 1985 period, Japanese firms' exposure is mostly negative (19% of all firms have significant negative exposure at the 10% level). The exposure effect is found to be positive during the post-September 1985 period which coincides with the Plaza Accord when the Group of Ten industrialized countries agreed to cooperate in an effort to bring down the real value of the U.S. dollar against major currencies, including the yen.

The sharp appreciation of the yen against the dollar (i.e., from 200 yen per dollar to 105 yen per dollar) and other major currencies during the October 1985 – December 1995 period appears to have been especially harmful for MNCs and high-exporting firms. MNCs' exposure, while negative, was insignificant during the first period, implying that exchange-rate gyrations did not have a sharp valuation effect. MNCs, however, have the largest number of positive significant exposure over the second period that is characterized by the dramatic appreciation of the yen (32% and 40% at the 5% and the 10% level of significance, respectively). This result suggests that the strong-yen had an adverse impact on MNCs' stock return performance. Similarly, high-exporting firms had the second largest significant positive exposure (22% and 33% at the 5% and 10% level of significance, respectively) among all four samples. As expected, low-exporting and domestic firms have much lower exchange-rate exposure than the other two types of firms.

Further, it is interesting to note that the currency exposure of exporting firms is predominately negative over the pre-Plaza Accord period. This result suggests that the market value of exporting firms was inversely related to the yen's fluctuations throughout this period. This could be attributed to the negative (positive) influence a depreciating (appreciating) yen has on exporting firms' operating cost exposure as they heavily rely on imported inputs of production (O'Brien (1994)). MNCs' market values, however, were not affected by the yen's gyrations during the first period as much as the exporting firms probably because of production and marketing efficiencies which would tend to reduce their operating cost exposure. It should be noted that exporting firms are not uniformly affected by the yen fluctuations over the 1975–1985 period. For instance, 8% of the 260 high-exporting firms had a significant positive exposure in response to the yen/dollar exchange-rate movements and 8% in response to the trade-weighted exchange rate movements at the 10% level of significance, respectively. Similarly, 7% of the 281 low-exporting firms registered a significant positive currency exposure with respect to the yen/dollar exchange-rate changes and 8% with respect to the trade-weighted exchange-rate changes at the 10% level of significance, respectively. This evidence implies that when the operating revenue exposure exceeds the operating cost exposure, a depreciating yen tends to exert a positive impact on the market value of exporting firms. That is, exporting firms that are more dependent on imported inputs of production are likely to be the most adversely affected by the yen's depreciation.

Domestic firms (i.e., firms with zero foreign sales to total sales) seem to be more sensitive to the yen's movements during the pre-Plaza Accord period. As expected, the negative exposure of domestic firms suggests that the yen's depreciation makes domestic firms vulnerable probably because of their dependence on foreign inputs of production. However, the exposure coefficient of domestic firms appears to be smaller and less statistically significant compared to low-exporting firms. This indicates that their production cost structure is different and less sensitive to exchange rate movements than that of low-exporting firms. As expected, the positive exposure of domestic firms, even though statistically insignificant during the post-Plaza Accord period, implies that the yen's sharp appreciation had a small negative valuation effect, most likely, due to the competition that domestic firms face from Japanese importing firms. The fact that domestic firms experienced such a mild adverse exposure effect may be attributed to the existence of trade barriers that prohibit the inflow of foreign products into the Japanese market (see, for example, Business Week (July 28, 1997)). The negative exposure of domestic firms, however, appears to be highest when it is measured against the yen/dollar exchange rate movements. This implies that a depreciation of the yen against the dollar has a significant adverse valuation impact on 9% to 16% of the 476 domestic firms possibly due to their reliance on dollar denominated inputs of production or use of domestically available inputs whose prices are determined in international markets. Panel B also shows that the sign of exposure is essentially the same for both exchange rates (BXR, TWXR) used in our analysis. Panels D1 and D2, show that these exposure results are robust across the pre and post-Plaza Accord sub-periods. The percentage of positive exposure coefficients has increased over time for MNCs and high-exporting firms by 34% and 25%, at the 10% level of significance, respectively. The implication of this result is that these two types of firms have felt the most adverse valuation effects from the appreciation of the yen.

This evidence is in sharp contrast with the existing empirical literature which documents a weak relationship between contemporaneous exchange rate changes and the market value of 287 U.S. MNCs (Jorion (1990)) and 32 U.S. large export-oriented (Amihud (1994)) firms over the 1979–83 and 1979–88 periods, respectively. Bartov and Bodnar (1994) also report a non-reliable relation between unexpected exchange rate changes and abnormal returns for 208 firms with foreign operations.

Time-Varying Exchange Rate Exposures

Our analysis based on model (3), specifies constant exposure of stock returns to currency exposure. Because the currency risk exposure of Japanese firms may be time varying, we conduct two tests to determine whether the assumption of constant currency risk exposure is appropriate.

Following Ferson's (1990) goodness-of-fit test of the assumption of constant betas, the following system of equations is estimated using the Generalized Method of Moments.

$$y_{j,t,\ t+1} = \Phi_j\ \mathrm{IV}_t + \mathrm{f}_{j,t,\ t+1}, \tag{3a}$$

$$\omega_{j,t,\ t+1} = f_{j,t,\ t+1}\ R_{i,t,\ t+1} - f^2_{j,t,\ t+1}\delta_{j,t} \tag{3b}$$

The first equation estimates surprises, f_j, in economic factors by regressing raw changes in economic factors, y_j, on IV, the lagged information variables including the relative size and financial factors, $R_{i,t-1}$, and a constant. The Φ_j represents a vector of parameters. In equation (3b), the first term represents the conditional covariance between the stock return and the jth risk factor. The expected value of the second term represents the conditional variance of the risk factor times a constant. If the true risk exposure is non-time varying, the two terms must be equal. When multiplied by the number of observations, the objective function of GMM testing procedure yields a test statistic that is asymptotically chi-squared with degrees of freedom equal to the number of orthogonality conditions minus the number of parameters. If the constant beta assumption holds, the statistic is not significantly different from zero. In the second test, the constant risk exposure, $\delta_{j,t}$, is replaced with a linear function which allows the risk exposure to depend on the lagged information variables. We report a test on the restriction that currency and market risks are constant in Japan, $\delta_{j,t,1} = \delta_{j,t,2} = 0$.

Panel E of Table I presents the results. Panel E1 presents the results of goodness-of-fit test. The system of equations is estimated separately for each group of firms and risk exposure. The first row stacks equations across groups of firms (portfolios). The results show that the assumption of constant risk exposure cannot be rejected. Only one portfolio rejects a constant exchange-rate risk beta at the 5% level. Most of the other goodness-of-fit statistics cannot reject the constant exposure assumption.

Panel E2 reports the tests of the significance of coefficients allowing time variation in betas. Time variation in exchange rate beta appears significant for

Panel E: Tests of Constant Risk Exposures

	Bilateral (BXR) Exchange Rate		Multilateral (TWXR) Exchange Rate	
E1: Constant Exposure to Risk Exposures				
	Currency	Market	Currency	Market
All Firms N = 1079	23.252 (0.338)	21.560 (0.673)	33.982 (0.441)	19.331 (0.810)
MNCs N = 62	4.001 (0.215)	0.329 (0.035)	6.390 (0.552)	0.223 (0.772)
High Exporters N = 260	7.302 (0.077)	0.592 (0.448)	5.729 (0.250)	.462 (0.238)
Low Exporters N = 281	4.689 (0.381)	0.410 (0.764)	3.285 (0.492)	0.392 (0.751)
Domestic Firms N = 476	3.680 (0.440)	0.085 (0.841)	4.039 (0.501)	0.621 (0.793)
E2: Allowing for Time-Variation in Risk Exposures*				
	Currency	Market	Currency	Market
All Firms N = 1079	35.006 (0.232)	45.028 (0.457)	31.228 (0.361)	42.152 (0.234)
MNCs N = 62	5.298 (0.004)	2.023 (0.082)	6.253 (0.001)	4.162 (0.039)
High Exporters N = 260	6.293 (0.006)	2.175 (0.840)	7.281 (0.077)	0.984 (0.632)
Low Exporters N = 281	5.115 (0.010)	3.173 (0.693)	8.157 (0.032)	1.628 (0.694)
Domestic Firms N = 476	8.193 (0.384)	0.471 (0.785)	6.910 (0.049)	0.961 (0.710)

* Note: Test whether slope coefficients allowing for linear time-variation in risk exposures are jointly equal to zero.

the MNCs and high exporting firms while time variation in stock market beta is significant for two out of five portfolios. In brief, the goodness-of-fit tests indicate that the constant beta assumption holds. Consistent with the evidence reported for other developed countries, the tests for time-varying betas show only a few cases were the time-varying specification may be required. The time-varying exposure assumption might be of greater importance in emerging markets given the rapid changes they go through. Bailey and Chung (1995), however, fail to find evidence in support of the view that exposure may be time varying even in the context of an emerging market environment. However, the time-varying exposure assumption is relaxed later.

Industry-Specific Exchange Rate Exposure Effects

At the industry-level, Bodnar and Gentry (1993) find 23% of the 39 industries analyzed with significant exchange rate exposure coefficients over the 1983–88 period. Their analysis, however, is based on aggregate industry portfolios that does not take into account the nature and characteristics of constituent firms in each industry. Unlike previous studies, we examine the exchange-rate exposure effects of Japanese industries by distinguishing constituent firms in each industry based on their foreign operations and international trade activities. This procedure resulted into 25 industries based on two-digit SIC codes. Firms within each industry are classified into one of the four types of firms (i.e., MNCs, High-exporting, Low-exporting and Domestic firms).

Table II reports the market-adjusted currency coefficients over the pre and post-Plaza Accord periods. Across industries, the currency exposure coefficients appear to be very different. MNCs and high-exporting firms, consistent with our previous results, seem to have the highest incidence of currency exposure during the post-Plaza Accord period. In addition, their sign of exposure is positive indicating that MNCs and high-exporting firms have been adversely affected by the sharp appreciation of the yen against the dollar and other major currencies during the post-Plaza Accord period. It is interesting to note that two thirds of the MNCs in our sample belong to the industries (i.e., industrial machinery (14), electronics (12), transportation equipment (10), instruments (5), and miscellaneous manufacturing (4)) with the most significant positive exposure coefficients. As expected, low-exporting and non-exporting industries show low exposure in response to unexpected yen movements. As shown earlier, firms from non-exporting industries exhibit a negative exposure. Since these industries tend to rely on imported factor inputs or domestically available factor inputs whose prices are determined in the context of international markets (see, for example, Business Week (November 11,1996)) tend to be adversely affected from the yen's depreciation. The trade-weighted exposure effects appear essentially similar to the yen/dollar exposure effects. Overall, the evidence corroborates our previous findings that Japanese firms are sensitive to exchange rate fluctuations with MNCs and high-exporting firms exhibiting pronounced and mostly positive exchange-rate exposure during the post-Plaza Accord period that coincided with

Table 2: Average Currency Exposure of Japanese Industries

This table reports the currency coefficients (β_{1i}'s) from the following model,

$$R_{it} = \beta_{0i} + \beta_{1i} f_{st} + \beta_{2i} f_{mt} + \varepsilon_{it}$$

inclusive of the instruments of information as explanatory variables. R_{it} is the rate of return on the ith industry's portfolio of common stock, f_{st} is the orthogonalized rate of change in the month-end spot rate of the Japanese yen/US dollar bilateral (BXR) exchange rate (or the rate of change in the month-end spot rate of the Japanese trade-weighted (TWXR) exchange rate) and f_{mt} is the orthogonalized market rate of return. The orthogonalized currency and market rates of return were obtained from the following models

$$\mathrm{R}_{st} = \phi_{0s} + \sum_{j=1}^{7} \phi_{js}\mathbf{IV}_{jt-1} + \sum_{i=1}^{2} \beta_{im}\mathbf{R}_{it-1} + \varepsilon_{st}$$

$$\mathrm{R}_{mt} = \phi_{0m} + \sum_{j=1}^{7} \phi_{jm}\mathbf{IV}_{jt-1} + \sum_{i=1}^{2} \beta_{im}\mathbf{R}_{it-1} + \beta_{sm}\hat{\varepsilon}_{st-1} + \varepsilon_{mt}$$

where R_{mt} is the log of the value-weighted stock market return based on the Nikkei 225 index, the Xj are macroeconomic variables where the coefficients ρ_j refer to: (IP) the lagged industrial production growth series which is constructed as the log of the price relatives of seasonally adjusted Japanese industrial production as reported by the IMF; (UI) the unanticipated inflation series which is estimated by subtracting the estimated inflation at month $t-1$ from the realized inflation rate during month t; (UTS) the term structure series is constructed from the difference between the Japanese long term bond series and short term loans; (MS) the lagged money supply series reflects the monthly change in the Japanese seasonally adjusted money supply; and (UJS) the US-Japanese interest rate spread which is the monthly return difference between US and Japanese short term bill rates. The coefficients β_i give sensitivities to the common factors where; VG is equal to the monthly return spread between a portfolio of Japanese value stocks (high book-to-market) and a portfolio of Japanese growth stocks (low book-to-market); SL is equal to the monthly return difference between a portfolio of Japanese small cap stocks and a portfolio of Japanese large cap stocks; and f_{st} is the rate of return in the month-end spot rate of the Japanese yen/US dollar bilateral (BXR) exchange rate (or the month-end Japanese trade weighted (TWXR) spot rate).

Note: Sample I is composed of firms identified as multinationals in *The World Directory of Multinational Enterprises*; Sample II is composed of firms with reported foreign sales to total sales in excess of 20%; Sample III is composed of firms with reported foreign sales to total sales in excess of 0%, but less than 20%; and Sample IV is composed of firms with no reported foreign sales to total sales. SIC indicates the industry's 2 digit SIC code. The number of firms for each cell is reported below the currency coefficient. * denotes significance at the 10% level, ** denotes significance at the 5% level and *** denotes significance at the 1% level. Chi square statistics test the hypothesis that the β_{1s} are jointly equal to zero across industries for each type of firm.

Panel A: Pre-Plaza Accord (January 1975–September 1985)

		Bilateral (BXR) Exchange Rate				Multilateral (TWXR) Exchange Rate			
Industry	SIC	MNCs	High Exporters	Low Exporters	Domestic Firms	MNCs	High Exporters	Low Exporters	Domestic Firms
Gen Bldg Contracts	15	−.244	−.315	−.035	−.585**	−.140	−.421	.099	−1.94**
		1	3	3	38	1	3	3	38
Heavy Construction	16			−.380	−.270			−.978	−1.18
				6	17			6	17
Special trade Contractors	17			−.246	.143			−1.14	1.42
				5	15			5	15
Food	20	−.137		−.112	−.374	−.130		.125	−1.30
		1		3	9	1		3	9
Textile Mill Products	22		.166	−.319*	−.015		.076	−1.37*	−.445
			5	12	12		5	11	12
Apparel Products	23				−.475*				−1.50*
					10				10
Paper & Products	26		.205	−.329	.319		.988	−1.64	.980
			6	8	12		6	8	12

Table 2: *Continued*

Industry	SIC	Bilateral (BXR) Exchange Rate				Multilateral (TWXR) Exchange Rate			
		MNCs	High Exporters	Low Exporters	Domestic Firms	MNCs	High Exporters	Low Exporters	Domestic Firms
Chemical	28	−.398*	−.488**	−.531*	−.413*	−1.92*	−3.14**	−3.06*	−2.61**
		8	20	6	32	8	20	6	32
Rubber & Plastic	30	−.093 3	−.197	.073	−.113	−1.52	−1.58	.260	−.512
		3	4	28	10	3	4	28	10
Stone, clay Glass	32	.247	−.019	−.138	−.297	.136	−.379	−.197	−1.22
		4	9	11	17	4	9	11	17
Primary Metal	33		−.742**	−.070	.162		−3.08**	−0.83.	.278
			6	9	25		6	9	25
Fabricated Metals	34			−.309**	−.373*			−1.85**	−1.87*
				12	28			12	28
Industrial Machinery	35	.115**	−139.	−.132	.094	.756**	1.23	.142	−.170
		14	48	47	33	14	48	47	33
Electronics	36	.763***	.403**	.166	−.115	3.79**	.667**	1.32	−.260
		12	64	43	24	12	64	43	24
Transport. Equipment	37	.457*	.573**	.422	.340	2.63**	3.63**	.884	.357
		10	16	39	23	10	16	39	23
Instruments	38	.556	.548	.069	.552	1.41	.887	.439	1.71
		5	26	16	9	5	26	16	9
Misc. Manufact.	39	.194	−.214	.311	.330	−.330	−1.40	.210	.432
		4	5	9	5	4	5	9	5
Water Transport	44		.127	−.140	−.120		.164	−1.30	−.495
			20	8	5		20	8	5
Electric, Gas Services	49				.115				.472

					6				6
Durable gds Wholesale	50		−.140	−.039	−.275*		−1.38	−.294	−2.39*
			15	12	18		15	12	18
Nondurable gds/wholesl	51		.177	−.193	.130		.576	−1.87	.416
			4	5	17		4	5	17
Gen Merchandise	53		−.389		−.212		−.764		−.784
			4		14		4		14
Depository Institutions	60				.219				.408
					83				83
Security Brokers	62		−.159		−.012		−.449		.112
			5		6		5		6
Insurance Carriers	63				−.220				−.496
					8				8
χ^2 Statistics		63.54***	59.67***	38.28*	35.62**	64.59***	47.78***	42.73**	49.14**

Panel B: Post-Plaza Accord (October 1985–December 1995)

		Bilateral (BXR) Exchange Rate				Multilateral (TWXR) Exchange Rate			
Industry	SIC	MNCs	High Exporters	Low Exporters	Domestic Firms	MNCs	High Exporters	Low Exporters	Domestic Firms
Gen Bldg Contractrs	15	.614	.373	−.121	.611	1.331	.535	−.374	.294
		1	3	3	38	1	3	3	38
Heavy Construction	16			−.414	−.787			−.250	−.867
				6	17			6	17
Special trade Contractors	17			.076	.358			.330	.738
				5	15			5	15
Food	20	−.398		−.355*	−.722	−.112		−.110	−.837

Table 2: *Continued*

Industry	SIC	Bilateral (BXR) Exchange Rate				Multilateral (TWXR) Exchange Rate			
		MNCs	High Exporters	Low Exporters	Domestic Firms	MNCs	High Exporters	Low Exporters	Domestic Firms
		1		3	9	1		3	9
Textile Mill Products	22		.373	1.037	−.130		.225	1.110	.306
			5	11	12		5	11	12
Apparel Products	23				−.211				.100
					10				10
Paper Products	26		−.092	−.230	.303		−.204	−.080	.140
			6	8	12		6	8	12
Chemical	28	−.361	−.395	−.786	.176	−.837	−.340	.176	.382
		8	20	6	32	8	20	6	32
Rubber & Plastic	30	.482	.318	.180	.0315	.602	.723	.302	.783
		3	4	28	10	3	4	28	10
Stone, clay Glass	32	.149	.049	.318	−.277	.231	−.108	.883	−.402
		4	9	11	17	4	9	11	17
Primary Metal	33		.042	−.348	.644		−.148	−.285	.947
			6	9	25		6	9	25
Fabricated Metals	34			.230	.272			.526	.430
				12	28			12	28
Industrial Machinery	35	.988**	.386*	−.117	−.064	1.325***	.732*	−.502	−.523
		14	48	47	33	14	48	47	33
Electronics	36	1.231***	1.140**	.847*	.049	1.240***	1.220**	1.020*	1.020
		12	64	43	24	12	64	43	24
Transport. Equipment	37	.487*	1.110**	.332	−.152	.624***	1.120*	.414	−.119
		10	16	39	23	10	16	39	23

Instruments	38	.237	.328***	.594*	.290	.340**	.733**	.734*	.112
		5	26	16	9	5	26	16	9
Misc. Manufact.	39	.162	.428*	.053	−.462	.405*	.832*	.092	−.322
		4	5	9	5	4	5	9	5
Water Transport	44		.030	−.054	−.630*		−.113	−.290	1.173**
			20	8	5		20	8	5
Electric, Gas Services	49				−.722				−.321
					6				6
Durable gds Wholesale	50		−.334	−.370	.342		−.490	−.597	.722
			15	12	18		15	12	18
Nondurable gds/wholesl	51		.430	.196	.237		.300	.302	1.302*
			4	5	17		4	5	17
Gen Merchandise	53		.137		.660		−.082		1.001
			4		14		4		14
Depository Institutions	60				−.602				−1.070
					83				83
Security Brokers	62		.123		.252		.320		.248
			5		6		5		6
Insurance Carriers	63				−.299*				−1.301*
					8				8
Chi-square Statistics		68.25***	65.07***	41.40**	37.90**	65.43***	63.49***	42.21**	39.73**

the yen's appreciation.These results do not conform with those reported by Bodnar and Gentry (1993) who identify five of the twenty Japanese industry portfolio returns, exclusive of dividends, with significant currency exposure. The chi-square values clearly reject the hypothesis of equal exposure across industries.

Non-Contemporaneous Exchange Rate Exposure

While our analysis reveals a significant association between contemporaneous exchange rate changes and Japanese stock returns, previous studies (Amihud (1994), and Bartov and Bodnar (1994)) document a relation only between lagged changes in the dollar and the value of U.S. firms. Amihud (1994) argues that cash flows are not immediately affected by exchange rate changes and firms' financial statements information reaches the market with a time lag. Bartov and Bodnar (1994) attribute stock returns' lagged response to exchange rate changes to investors' systematic errors in determining the impact of exchange-rate movements on firm performance because of the complex set of issues involved in characterizing the linkage between firm value and exchange rate fluctuations. We test the lagged-response hypothesis in a single regression of stock returns against market-adjusted current and lagged exchange-rate changes.

$$R_{it} = \beta_{0i} + \beta_{1i}\,\hat{\varepsilon}_{st} + \beta_{2i}\,\hat{\varepsilon}_{st-1} + \beta_{3i}\,\hat{\varepsilon}_{mt} + \eta_{it} \tag{5}$$

The lagged-response hypothesis is tested using a modified version of equation (4)equation (4).[20] If investors systematically misprice the relation between firm value and exchange-rate changes because of the complex issues associated with the full-characterization of this relationship, the parameter β_{2i} which measures the effect of lagged exchange rate changes on current stock returns is expected to be statistically significant at conventional levels. If the relation between firm value and changes in the foreign value of the yen is not difficult to characterize by investors, a weak relation between stock returns and lagged exchange rate changes should emerge.[21]

Table III reports current and lagged exposure coefficients for the entire sample and the four types of firms. The lagged exposure coefficients are not significant at any conventional level, while the magnitude and significance of the coefficients of the contemporaneous exchange rate variable remain unchanged. In addition, we report chi-square statistics that test the hypothesis that the lagged exposure coefficients are jointly zero. The low values for the chi-square test statistic indicate that the null hypothesis cannot be rejected at the 5% level of significance. The results are robust across the different types of firms and across the trade-weighted exchange rate variable. In comparison to the results reported in Panel C of Table I, the percentage of significant coefficients on the

[20] Instrumental variables are also included in the estimation of (5).

[21] Consistent with the contemporaneous tests, the lagged response hypothesis tests account for the influence of the instrumental variables as well.

Table 3: Lagged Currency Exposure of Japanese Firms

This table reports the average contemporaneous and lagged currency (β_{1i}'s and β_{2i}'s) and market (β_{3i}'s) coefficients from the following model,

$$R_{it} = \beta_{0i} + \beta_{1i} f_{st} + \beta_{2i} f_{st-1} + \beta_{3i} f_{mt} + \varepsilon_{it}$$

where R_{it} is the rate of return on the ith firm's common stock, f_{st} is the orthogonalized rate of change in the month-end spot rate of the Japanese yen/US dollar bilateral (BXR) exchange rate (or the rate of change in the month-end spot rate of the Japanese trade-weighted (TWXR) exchange rate) and f_{mt} is the orthogonalized market rate of return. The orthogonalized currency and market rates of return were obtained from the following models

$$R_{st} = \phi_{0s} + \sum_{j=1}^{7} \phi_{js} IV_{jt-1} + \sum_{i=1}^{2} \beta_{im} R_{it-1} + \varepsilon_{st}$$

$$R_{mt} = \phi_{0m} + \sum_{j=1}^{7} \phi_{jm} IV_{jt-1} + \sum_{i=1}^{2} \beta_{im} R_{it-1} + \beta_{sm} \hat{\varepsilon}_{st-1} + \varepsilon_{mt}$$

where R_{st} is the rate of change in the month-end spot rate of the Japanese yen/US dollar bilateral (BXR) exchange rate (or the rate of change in the Japanese trade-weighted (TWXR) exchange rate), the ϕ's are the slope coefficients of the instrumental variables (IV_j) described in section I, including the lagged exchange rate variable and an export-import (XM) variable retrieved from *IFS* (IMF), and R_{mt} is the log of the value-weighted stock market return based on the Nikkei 225 index. The Xj are macroeconomic variables which explain the equity risk premia and the coefficients ρ_j refer to: (IP) the lagged industrial production growth series which is constructed as the log of the price relatives of seasonally adjusted Japanese industrial production as reported by the IMF; (UI) the unanticipated inflation series which is estimated by subtracting the estimated

Table 3: *Continued*

inflation at month $t-1$ from the realized inflation rate during month t; (UTS) the term structure series is constructed from the difference between the Japanese long term bond series and short term loans; (MS) the lagged money supply series reflects the monthly change in the Japanese seasonally adjusted money supply; (UJS) the US-Japanese interest rate spread which is the monthly return difference between US and Japanese short term bill rates; and (XM) the trade balance series, estimated as the monthly logarithmic difference between exports and imports. The coefficients β_i give sensitivities to the common factors where; f_{vg} is the monthly return spread between a portfolio of Japanese value stocks (high book-to-market) and a portfolio of Japanese growth stocks (low book-to-market); and f_{sl} is the monthly return difference between a portfolio of Japanese small cap stocks and a portfolio of Japanese large cap stocks.

Note: Sample I is composed of firms identified as multinationals in *The Directory of Multinational Enterprises*; Sample II is composed of firms with reported foreign sales to total sales in excess of 20%; Sample III is composed of firms with reported foreign sales to total sales in excess of 0%, but less than 20%; and Sample IV is composed of firms with no reported foreign sales to total sales.

Panel A reports the slope coefficients of both the market and currency terms, chi square, and R^2 statistics. Panel B reports the percentage of significant positive (N^+) and negative (N^-) currency exposure coefficients, at both the 5% and 10% level of significance. N = the number of firms in each sample. * denotes significance at the 10% level, ** denotes significance at the 5% level and *** denotes significance at the 1% level. Chi-square statistics test the hypothesis that the β_2's are jointly equal to zero across firms within each sample.

Type of Firm	Bilateral (BXR) Exchange Rate					Multilateral (TWXR) Exchange Rate[1]				
	β_1	β_2	β_3	χ^2	R^2	β_1	β_2	β_3	χ^2	R^2
All Firms N = 1079										
Jan 75–Sep 85	−.245*	−.301	1.02***	.171	.2871	−.888*	−.102	1.15**	.418	.3444
Oct 85–Dec 95	.301**	.202	.616**	.187	.1810	1.09**	.217	3.29**	.109	.1604
Jan 75–Dec 95	.096	−.111	.519*	.194	.1588	−.110	.098	.461*	.216	.1666
MNCs N = 62										
Jan 75–Sep 85	.161	.039	1.29***	.161	.3198	.036	−.055	1.13***	.293	.2597
Oct 85–Dec 95	.431**	.094	.737**	.701	.2218	1.38*	.217	.509*	.514	.1906
Jan 75–Dec 95	.187	−.136	.259*	.356	.1065	.598	−.102	.452*	.082	.1113
High Exporters N = 260										
Jan 75–Sep 85	−.187*	.124	1.09***	.342	.3098	−.054	−.141	1.10***	.334	.2226
Oct 86–Dec 95	.466*	.046	.662**	.184	.2165	1.97**	.076	.369**	.562	.1903
Jan 75–Dec 95	.153	−.103	.506**	.342	.1194	.483	.234	.232*	.300	.1043

Table 3: *Continued*

Type of Firm	Bilateral (BXR) Exchange Rate					Multilateral (TWXR) Exchange Rate[1]				
	β_1	β_2	β_3	χ^2	R^2	β_1	β_2	β_3	χ^2	R^2
Low Exporters										
N = 281										
Jan 75–Sep 85	−.298*	.088	.788***	.541	.3498	−1.46**	.120	.898***	.194	.4658
Oct 85–Dec 95	.242*	−.112	.453**	.656	.1578	.943*	−.434	.443**	.126	.2108
Jan 75–Dec 95	.127	−.034	.334*	.543	.0985	−.433	.388	.406**	.321	.1004
Domestic firms										
N = 476										
Jan 75–Sep 85	−.288*	.019	.735***	.354	.2334	−.701	−.233	.654***	.216	.3543
Oct 85–Dec 95	.234	.343	.384**	.116	.0876	.398	.143	.482**	.545	.1344
Jan 75–Dec 95	.094	−.117	.244*	.719	.1128	−.278	−.105	.243*	.303	.0689

[1] Multilateral exchange rate series begins January 1978.
Critical values of χ^2, df = 1: @10% = 2.706; @5% = 3.841; @1% = 6.635.

lagged exchange-rate variable is extremely low regardless of the exchange-rate risk measure used (not reported here). This evidence suggests that lagged exchange rate changes have no significant power in explaining Japanese stock price changes. Hence, this is inconsistent with the view that investors have difficulty in characterizing the complex relation between currency changes and firm value.

The lack of evidence in support of the lagged-response hypothesis in Japan could be attributed to both the different methodology used and the nature of our data set in comparison to other studies. However, since our sample includes firms with different foreign involvement, it is reasonable to assume that the lagged response of stock returns to exchange rate changes is more likely to be detected in low exporting and domestic firms than high exporting and multinational firms. Because the latter group of firms in our sample is more comparable to the samples used in previous studies, we conclude that the limited success of these studies to identify a significant relation between changes in exchange rates and contemporaneous stock returns is more likely to be associated with their methodology rather than the nature of data used. As in Amihud (1994), we have also included lags up to the sixth order for the exchange rate variable including the instrumental variables. Consistent with our results listed in Table III, these results, not reported here, did not produce any reliable evidence in support of the lagged exchange-rate effects on corporate value.[22] Overall, these findings are inconsistent with the view that the effects of exchange rate change on future cash flows of the firm are difficult for investors to ascertain.

In view of the lack of evidence of lagged exposure effects at the firm level, we re-examined the lagged-response hypothesis at the industry-level. The evidence, not reported here, rejects the hypothesis that lagged changes in the yen are associated with Japanese industry stock returns. This is also confirmed by the chi-square test results which fail to reject the hypothesis that the lagged exposure coefficients are all equal to zero at conventional levels of significance. Hence, this evidence is also inconsistent with earlier findings based on U.S. data that support the mispricing of contemporaneous exchange rate effects on stock returns. Additionally, to confirm the robustness of these results the analysis is repeated with the inclusion of lags up to the sixth order for the exchange rate variable. In line with our firm level analysis, these results, not reported here, failed to produce any evidence of lagged exchange-rate effects.[23]

IV. SOURCES OF EXCHANGE RATE EXPOSURE

The preceding results suggest that Japanese firms, including those with no foreign operations, are sensitive to unanticipated exchange-rate changes.

[22] Jorion (1990) and Amihud (1994) consider only U.S. multinational firms with reported foreign operations and large U.S. exporting firms, respectively.

[23] These results, not reported due to space limitations, are available from the authors upon request.

However, the cross-sectional variations in exposure coefficients are quite distinct across firms and that calls for an examination of the sources of exchange rate exposure of Japanese firms. The next issue we examine is whether a firm's foreign exchange-rate exposure is related to its degree of involvement in international trade activities. We also investigate the impact of currency hedging on the firm's exposure. We test these hypotheses by estimating the following

$$\hat{\beta}_{1i} = \gamma_{0i} + \sum_{j=1}^{n} \gamma_i F_{ji} + \upsilon_{it} \qquad (6)$$

cross-sectional regression where β_{1i} is the estimated exposure beta obtained from equation (3) and F_{ji} is the firm's ratio of foreign sales to total sales, the year-end stock price by the number of outstanding shares of common stock (i.e., the market capitalization of the firm), the debt to asset ratio of the firm, and the firm's return on assets. Alternatively, we use the absolute exposure beta in estimating (6) to account for beta differences across firms.[24]

Consistent with Shapiro (1975), Levi (1983) and Jorion (1990), we expect that the firm's currency exposure should be positively related to the ratio of foreign sales to total sales. In general, the use of foreign currency hedging should lessen a firm's foreign exchange rate exposure. In a recent survey conducted by the Treasury Management Association (TMA) and two other surveys by the Weiss Center for International Financial Research of the Wharton School, it was found that the use of financial derivatives for hedging currency risk increases with the size of the firm (Phillips (1995), Bodnar, Hayt, Marston and Smithson (1995), and Bodnar, Hayt, Marston (1996)). Because there is no available information on the hedging activities of Japanese firms, we cannot directly analyze the relationship between the firm's use of currency hedging instruments and its exchange-rate exposure. Following, however, the recent U.S. survey-based findings on the use of currency hedging instruments, Japanese firms' use of foreign currency hedging is proxied by the firm's size. Consistent with the evidence of U.S. firms' hedging activities, our hypothesis suggests that larger firms are more likely to be exposed to exchange-rate movements than firms with smaller involvement in international transactions. Hence, we expect that larger firms would make greater use of foreign currency derivatives and therefore have lower exchange rate exposure. In particular, we predict an inverse relationship between exchange rate exposure and firm size. Because firms may also use foreign debt as an alternative way of hedging foreign currency risk (i.e., money-market hedge strategy), the use of foreign debt should exert a negative influence on the firm's foreign currency expoure. Recent U.S. empirical evidence supports the inverse relationship between

[24] Estimation of regression (6), using instead the absolute exposure beta, produced qualitatively similar results to those reported in Table V. These results are available from the authors.

foreign debt and corporate exchange rate exposure (Allayannis and Ofek (2001)).

To test the merit of the money-market hedge hypothesis, we use the Japanese firm's debt to asset ratio due to the lack of corporate foreign debt data. This is mainly due to the fact that most Japanese firms do not report consolidated accounting information. Despite the fact that this variable may introduce noise into the analysis, it is expected that certain insights may be gained by its use. Specifically, we expect to find an inverse relationship between the debt to asset ratio and the firm's exchange rate exposure. Finally, Culp and Miller (1995) have made the observation that most value-maximizing firms do not hedge, implying that efficiently managed firms have low currency exposures. This suggests that currency exposure must be inversely related with the firm's efficiency in managing its operations. We investigate this observation by using the firm's return on assets (equity) as a benchmark of corporate efficiency.

Regression results for equation (6) are reported in Table IV. Overall, we find that the foreign sales to total sales ratio is significantly related to firm's exchange-rate exposure. As shown in Panel A, the estimated coefficient is positive and significant for both sub-periods but much more pronounced for MNCs than the other types of firms. Similar results were obtained, not reported here, using the firm's foreign sales scaled to the size of the firm variable as an alternative to firm's ratio of foreign sales to total sales and re-estimating (6) over both sub-periods. These results are consistent with Jorion's (1990) evidence for 287 U.S. multinational firms over the 1971–1987 period.[25] Hence, these findings are in line with the view that exchange rate exposure is positively related to firms' foreign involvement and operations measured by the foreign sales variable. As expected, the results also show that the market capitalization of the firm is inversely related to the Japanese firms' exchange-rate exposure implying that currency hedging usage increases with the size of the firm resulting in lower foreign currency exposure. It is interesting to point out that this inverse relationship is stronger during the more recent period that is characterized by a greater variety and more sophisticated financial derivatives. This result appears to be consistent with the findings of the three recent U.S. surveys on the usage of financial derivatives which show that larger firms tend to use more derivatives for managing exchange rate exposure.

For smaller firms, such as the low-exporting firms, our results confirm the view that smaller firms do not make extensive use of foreign currency derivatives due to their limited exposure needs and, perhaps, the high fixed start-up costs of hedging. Further, the evidence with respect to the debt/asset ratio variable, proxying for the money-market hedge strategy of Japanese firms, implies that exchange rate exposure declines when Japanese firms engage in raising foreign

[25] However, our results are stronger than Jorion's and the difference could be attributed to his (i) sample size and (ii) period of investigation that is skewed towards the early years of the floating exchange-rate period.

Table 4: Determinants of Economic Exposure

This table reports the γ_j coefficients from the regression;

$$\hat{\beta}_{1i} = \gamma_{0i} + \sum_{j=1}^{4} \gamma_j \, F_{ji} + \upsilon_i$$

where F_{ji} is the firm's ratio of foreign sales to total sales; the market capitalization of the firm, measured as the year-end stock price by the number of outstanding shares of common stock; the debt/asset ratio of the firm; the firm's return on assets (ROA); and β_{1i} is the estimated exposure beta generated from the equation:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{st} + \beta_{2i} R_{mt} + \varepsilon_{it}$$

$$R_{st} = \phi_{0s} + \sum_{j=1}^{7} \phi_{js} \, IV_{jt-1} + \sum_{i=1}^{2} \beta_{im} R_{it-1} + \varepsilon_{st}$$

$$R_{mt} = \phi_{0m} + \sum_{j=1}^{7} \phi_{jm} \, IV_{jt-1} + \sum_{i=1}^{2} \beta_{im} R_{it-1} + \beta_{sm} \hat{\varepsilon}_{st-1} + \varepsilon_{mt}$$

inclusive of the instruments of information as explanatory variables. R_{it} is the rate of return on the ith firm's common stock, R_{st} is the orthogonalized rate of change in the month-end spot rate of the Japanese yen/US dollar bilateral (BXR) exchange rate (or the rate of change in the month-end spot rate of the Japanese trade-weighted (TWXR) exchange rate) and R_{mt} is the orthogonalized market rate of return. The orthogonalized currency and market rates of return were obtained from the following modelswhere R_{st} is the rate of change in the month-end spot rate of the Japanese yen/US dollar bilateral (BXR) exchange rate (or the rate of change in the Japanese trade-weighted (TWXR) exchange rate), R_{mt} is the log of the value-weighted stock market return based on the Nikkei 225 index, the ϕ's are the slope coefficients of the instrumental variables (IV) where (IP) is the lagged industrial production growth series which is constructed as the log of the price relatives of seasonally adjusted Japanese industrial production as reported by the IMF; (UI) is the lag of the unanticipated inflation series which is estimated by subtracting the estimated inflation at month t-1 from the realized inflation rate during month t; (UTS) is the lag of the term structure series which is constructed from the difference between the Japanese long term bond series and short term loans; (MS) is the lagged money supply series which

reflects the monthly change in the Japanese seasonally adjusted money supply; (UJS) is the lag of the US-Japanese interest rate spread which is the monthly return difference between US and Japanese short term bill rates; (XM) is the lag of te trade balance series, estimated as the monhly logarithmic difference between exports and imports, and the lagged dependent variable. The coefficients β_i give sensitivities to the common macro-factors, R_{it-1} represents a set of common factors such as the monthly return spread between a portfolio of Japanese value stocks (high book-to-market) and a portfolio of Japanese growth stocks (low book-to-market), the monthly return difference between a portfolio of Japanese small cap stocks and a portfolio of Japanese large cap stocks, and $\hat{e}_{st}$ is the estimated residual currency factor.
Note: The sample is composed of all firms, excluding domestic firms. Domestic firms are excluded as their ratio of foreign sales to total sales equals zero. N = the number of firms in each sample. Industries with less than 10 firms have been omitted. * denotes significance at the 10% level, ** denotes significance at the 5% level, and *** denotes significance at the 1% level. T statistics are reported in parentheses.

Panel A: Determinants of Economic Exposure of Japanese Firms

		Pre-Plaza Accord Period Jan 1975–Sep 1985				Post-Plaza Accord Period Oct 1985–Dec 1995			
Type of Firm	Exchange Rate	Foreign Sales/ Total Sales	Market Cap	Debt/ Asset Ratio	Return on Assets	Foreign Sales/ Total Sales	Market Cap	Debt/ asset Ratio	Return on Assets
All Firms N = 603	Bilateral Exchange Rate	.0112 (3.87)***	.0826 (1.32)	−.0037 (−3.17)**	.0531 (.417)	.0172 (2.11)**	−.5120 (−2.23)**	−.0230 (−1.94)*	.6732 (.342)
	Multilateral Exchange Rate	.0221 (3.96)***	.0420 (1.34)	−.0064 (−1.82)*	−.1290 (−.384)	.0303 (2.37)**	−.4571 (−2.18)**	−.0121 (−1.85)*	.4133 (.860)
MNCs N = 62	Bilateral Exchange Rate	.0103 (3.48)***	−.0643 (−1.30)	−.0126 (−2.01)**	.0019 (.143)	.0201 (2.81)***	−.1102 (−2.10)**	−.0271 (−2.05)*	.0359 (.971)

Table 4: *Continued*

		Pre-Plaza Accord Period Jan 1975–Sep 1985				Post-Plaza Accord Period Oct 1985–Dec 1995			
Type of Firm	Exchange Rate	Foreign Sales/ Total Sales	Market Cap	Debt/ Asset Ratio	Return on Assets	Foreign Sales/ Total Sales	Market Cap	Debt/ asset Ratio	Return on Assets
	Multilateral Exchange Rate	.0411 (3.51)***	−.0355 (−1.20)	−.0430 (−1.84)*	.1121 (.240)	.0310 (3.21)***	−.1140 (−1.76)*	−.0216 (−2.03)**	.022 (.392)
High Exporting Firms N = 260	Bilateral Exchange Rate	.0034 (2.21)**	.0512 (1.14)	−.0039 (−1.97)*	.0199 (.662)	.0121 (1.72)*	−.0234 (−2.21)**	−.0138 (−1.96)*	*.2061* *(.24)*
	Multilateral Exchange Rate	.008 (2.01)**	.0332 (.731)	−.0028 (−2.06)*	.0365 (.336)	.0150 (1.91)*	−.0090 (−1.63)*	−.0097 (−1.98)*	−.0303 (−1.35)
Low Exporting Firms N = 281	Bilateral Exchange Rate	.0321 (1.77)*	.0752 (.512)	−.0140 (−.533)	.1163 (.882)	.0405 (1.72)*	−.2670 (−1.33)	−.0221 (−.664)	−.0850 (−1.22)
	Multilateral Exchange Rate	.0165 (1.85)*	.0112 (.616)	−.0037 (−.322)	.6330 (1.24)	.0537 (1.94)*	−.2086 (−1.38)	−.0176 (−.893)	−.0653 (−.874)

Panel B: Determinants of Economic Exposure of Japanese Industries

		Pre-Plaza Accord Period Jan 1975–Sep 1985				Post-Plaza Accord Period Oct 1985–Dec 1995			
Type of Firm	Exchange Rate	Foreign Sales/ Total Sales	Market Cap	Debt/ Asset Ratio	Return on Assets	Foreign Sales/ Total Sales	Market Cap	Debt/ Asset Ratio	Return on Assets
Textile Mill Products SIC = 22 N = 16	Bilateral Exchange Rate	.1221 (1.31)	.0291 (.329)	−.3340 (−1.92)*	.3090 (.632)	.044 (1.97)*	.0403 (1.20)	−.4856 (−2.53)**	.0662 (.105)
	Multilateral Exchange Rate	.0922 (.986)	.1201 (.524)	−.1291 (−2.15)**	−.6320 (−.521)	.1215 (2.17)*	.1650 (1.34)	−.6742 (−2.52)**	.3120 (.036)
Paper Products SIC = 26 N = 14	Bilateral Exchange Rate	.0476 (1.95)*	.0856 (.690)	−.1176 (−1.32)	.0391 (.223)	.0634 (2.07)*	.0870 (1.23)	−.1522 (−1.32)	−.2110 (−.724)
	Multilateral Exchange Rate	.0531 (1.94)*	.2310 (.818)	−.1550 (−1.40)	.0602 (.371)	.0826 (1.85)*	.4130 (1.02)	−.0870 (−1.26)	(−.4390) (−.061)
Chemical SIC = 28 N = 36	Bilateral Exchange Rate	.0652 (2.03)**	.1301 (.915)	−.0034 (−1.86)*	.0063 (.079)	.0764 (2.36)**	−.1020 (−1.25)	−.0054 (−1.83)*	.0314 (.656)
	Multilateral Exchange Rate	.0582 (1.88)*	.1255 (.810)	−.0040 (−1.89)*	.0220 (.114)	.0716 (2.14)**	−.1560 (−1.50)	−.0044 (−2.01)**	.0651 (.645)
Rubber & Plastic SIC = 30 N = 35	Bilateral Exchange Rate	.0310 (1.67)	.0643 (1.30)	−.0022 (−.205)	−.3068 (−.480)	.0467 (1.48)	−.0847 (−.697)	−.0031 (−.964)	−.0301 (−.351)

Table 4: *Continued*

Type of Firm	Exchange Rate	Pre-Plaza Accord Period Jan 1975–Sep 1985				Post-Plaza Accord Period Oct 1985–Dec 1995			
		Foreign Sales/ Total Sales	Market Cap	Debt/ Asset Ratio	Return on Assets	Foreign Sales/ Total Sales	Market Cap	Debt/ Asset Ratio	Return on Assets
	Multilateral Exchange Rate	.0308 (1.62)	.0852 (1.60)	−.0011 (−.452)	.0272 (.122)	.0560 (1.81)*	−.1104 (−1.34)	−.0314 (−1.20)	.1320 (.022)
Stone, Clay & Glass SIC = 32 N = 24	Bilateral Exchange Rate	.0145 (.640)	.0481 (.141)	−.0031 (−.166)	.0317 (.068)	.0364 (1.42)	−.0716 (−1.43)	−.0434 (−1.79)*	−.0613 (−1.34)
	Multilateral Exchange Rate	.0029 (.180)	.0421 (.102)	−.0044 (−.211)	−.0201 (−.138)	.0385 (1.47)	−.1167 (−1.43)	−.0414 (−1.72)*	−.0460 (−.657)
Primary Metal SIC = 33 N = 15	Bilateral Exchange Rate	.0934 (.286)	.0430 (.610)	−.0035 (−.074)	.1116 (.974)	.0603 (1.76)*	−.0683 (−.802)	−.0445 (−1.58)	.0645 (.057)
	Multilateral Exchange Rate	.735 (.433)	.0307 (.253)	−.0025 (−.101)	.0938 (.726)	.0465 (1.45)	−.1020 (−1.31)	−.0535 (−1.53)	.0042 −.0301
Fabricated Metals SIC = 34 N = 12	Bilateral Exchange Rate	.0101 (1.35)	.0556 (.504)	.0049 (.104)	.0131 (.127)	.0338 (1.51)	−.0142 (−1.32)	−.0143 (−.785)	−.0031 (−.776)
	Multilateral Exchange Rate	.0343 (1.77)*	.0722 (.532)	−.0031 (−.060)	.0306 (.045)	.0411 (1.85)*	−.0302 (−1.50)	−.0123 (−1.30)	−.0660 (−.712)

Industrial Machinery SIC = 35 N = 112	Bilateral Exchange Rate	.0440 (2.41)**	.1160 (1.21)	−.0024 (−1.82)*	−.1092 (−.245)	.0523 (1.78)*	−.1463 (−2.40)**	−.0663 (−1.23)	−.0074 (−.352)
	Multilateral Exchange Rate	.0650 (2.22)**	.0755 (.635)	−.0031 (−1.90)*	−.0653 (−.330)	.0634 (2.12)**	−.1446 (−2.09)**	−.0412 (−.556)	.0124 (.073)
Electronics IC = 36 N = 127	Bilateral Exchange Rate	.0314 (2.66)***	.0450 (1.57)	−.0028 (−2.11)**	.0042 (.134)	.0276 (2.10)**	−.4112 (−1.72)*	−.0210 (−.680)	−.0624 (−.015)
	Multilateral Exchange Rate	.0312 (2.33)***	.0312 (1.12)	−.0034 (−2.04)**	.2110 (.340)	.0224 (2.03)**	−.3612 (−1.93)*	−.0322 (−1.12)	−.1038 (−.340)
Transportation SIC = 37 N = 65	Bilateral Exchange Rate	.0334 (2.30)**	.0538 (1.40)	−.0026 (−1.73*	.0134 (.342)	.0220 (2.06)**	−.2316 (−2.11)*	−.0512 (−1.83)*	.0468 (.312)
	Multilateral Exchange Rate	.0291 (2.21)**	.0442 (1.51)	−.0028 (−1.84)*	.0302 (.612)	.0166 (2.18)**	−.2032 (−1.85)*	−.1601 (−2.04)*	.0421 (.320)
Instruments SIC = 38 N = 49	Bilateral Exchange Rate	.0232 (2.16)**	.0043 (.515)	−.0093 (−2.20)**	.0842 (.125)	.0078 (1.94)*	−.0837 (−1.94)*	−.0765 (−.552)	−.0681 (−1.10)
	Multilateral Exchange Rate	.0180 (2.02)**	.1103 (.349)	−.0082 (−2.22)**	.1137 (.160)	.0112 (1.85)*	−.1132 (−1.95)*	−.0470 (−.668)	−.0693 (−1.42)

Table 4: *Continued*

		Pre-Plaza Accord Period Jan 1975–Sep 1985				Post-Plaza Accord Period Oct 1985–Dec 1995			
Type of Firm	Exchange Rate	Foreign Sales/Total Sales	Market Cap	Debt/Asset Ratio	Return on Assets	Foreign Sales/Total Sales	Market Cap	Debt/Asset Ratio	Return on Assets
Misc. Manufactur SIC = 39 N = 18	Bilateral Exchange Rate	.094 (1.85)*	.0409 (.834)	−.0060 (−1.81)*	.0123 (.209)	.0122 (1.87)*	−.2333 (−1.40)	−.0502 (−.534)	.0076 (.553)
	Multilateral Exchange Rate	.0101 (1.91)*	.0132 (1.16)	−.0045 (−1.74)*	.0112 (.140)	.0114 (1.65)*	−.1122 (−1.30)	−.0660 (−.849)	(.0677) (.522)
Water Transport SIC = 44 N = 32	Bilateral Exchange Rate	.0032 (1.85)*	.0164 (.646)	−.0024 (−1.72)*	.0046 (.320)	.0073 (1.86)*	−.2012 (−1.75)*	−.0082 (−.583)	.0942 (.522)
	Multilateral Exchange Rate	.0036 (1.93)*	.0430 (.480)	−.0048 (−1.64)*	.0156 (.411)	.0103 (1.45)	−.2040 (−1.70)*	.0102 (.042)	.0461 (.570)
Durable Goods SIC = 50 N = 29	Bilateral Exchange Rate	.0310 (2.14)**	.0331 (.577)	−.0116 (−1.41)	.0150 (.077)	.0354 (1.72)*	−.0064 (−1.36)	−.0204 (−.614)	−.0216 (−.301)
	Multilateral Exchange Rate	.0116 (1.33)	.0236 (.623)	−.0222 (−1.85)*	.0204 (.137)	.0540 (1.84)*	−.0217 (−1.92)*	−.0074 (−.223)	.0246 (.412)

debt to manage exchange-rate risk. The most interesting result, perhaps, is that the coefficient of the debt/asset ratio variable appears with the same negative sign in both periods and slightly more significant during the first period when there was neither a broad array of derivatives and hedging strategies available to manage exchange-rate risk. In our tests, the return-on-assets variable does not appear to be significantly related to the firm's exposure. This result does not support the view that value-maximizing firms have low currency exposures. The inclusion of the return on equity measure as an alternative variable, not reported here, does not materially affect our results.

Consistent with the firm-specific results, the analysis of the economic exposure of Japanese industries shows that the foreign sales to total sales ratio is positively and significantly related to industry's exchange rate exposure in ten out of fourteen industries during the first period and in thirteen out of fourteen industries during the second period.[26] For industries with relatively low foreign involvement and operations, such as Rubber & Plastic, and Stone, Clay & Glass, the evidence supports the existence of low exchange-rate exposure, as expected. The results also indicate that the market capitalization variable is inversely related to the industry's exchange-rate exposure and that this relationship is more significant during the latter period of the analysis. This result is consistent with those reported at the firm level. The debt to asset ratio variable appears to be inversely related to the industry's exchange rate exposure and is statistically significant, at conventional levels, in nine out of fourteen industries during the pre-Plaza Accord period and only in four out of fourteen industries during the post-Plaza Accord period. This result is also consistent with the firm-specific evidence and in favor of the view that the money-market hedging strategy was more frequently used during the early years of the floating-rate period when the availability of derivatives and hedging strategies to manage exchange-rate risk were limited compared to the hedging instruments and strategies available over the recent years. Finally, the return-to-assets variable is not significant, at any conventional level, for all industries. The use of industry equity returns as an alternative performance measure, not reported here, produced similar results.

V. THE PRICING OF CURRENCY RISK IN THE JAPANESE CAPITAL MARKET

The association between endogenous variables, such as stock market returns and exchange rates, discussed earlier, may just reveal the simultaneous influence of monetary factors on exchange rates and stock returns. If exchange rates and stock returns are generated by a set of common macroeconomic factors, then stock prices should be responsive to unanticipated exchange rate changes after controlling for the influence of the common macroeconomic factors. Because

[26] Industries with less than ten firms have been omitted from the analysis in order to obtain more meaningful results by avoiding potential small-sample bias problems.

exchange rate fluctuations are central to several problems in international financial management, foreign currency exposure must be verified in the context of an asset-pricing framework before we draw any inferences about the importance of exchange rate movements on firm value. If the effects of currency movements are not diversified away, exposure to the currency risk factor should be rewarded with a risk premium in an asset market in equilibrium. Thus, share prices are likely to reflect an ex ante premium for exchange rate risk.

Recent empirical evidence on the pricing of currency risk, at the aggregate national stock market level for Germany, Japan, the United Kingdom and the United States (Dumas and Solnik (1995), and DeSantis and Gerard (1998)), however, appears to be inconsistent with the U.S. based results of the earlier literature (Jorion (1991)). Dumas and Solnik (1995), and DeSantis and Gerard (1998), among others, show that time varying exchange risk receives a statistically significant price in international capital markets, implying that investors are sensitive to currency risk exposure and expect to be compensated from bearing currency risk. Similarly, Doukas, Hall and Lang (1999) show that currency risk is priced when pricing tests are designed to account for time-varying risk premia in response to changes in macroeconomic conditions. A limitation of their pricing tests, however, is associated with the fact that they do not account for second moments. This conflicting evidence raises further the need to investigate whether currency risk is priced at the firm level in Japan. Second, if currency risk is priced it is interesting to know whether investors' required compensation for bearing currency risk varies across firms. Apparently, the findings of this investigation have direct asset pricing and currency hedging implications.

Unlike previous studies, we address the relevance of currency risk in the context of an intertemporal asset pricing framework which allows the currency risk premium to vary over time while it accounts for information that is available to investors. Investors' conditioning information in the empirical analysis is expressed in terms of instrumental variables. Conditional currency pricing tests, then, represent an integral part of our analysis. We search for time-varying premiums for currency risk using a unique data set. This feature of our approach departs from previous efforts and allows us to provide new evidence on the pricing of exchange-rate risk in the Japanese stock market.[27]

A Conditional Currency Pricing Model

While the above evidence suggests that currency risk is priced under the assumption that currency risk is time-invariant, it is quite possible that exchange-rate

[27] Previous studies concerned with the pricing of currency risk in the U.S. stock market (Jorion (1991)) have been based on the assumption that the currency risk premium is constant over time. Hence such tests do not permit the changing business conditions and market's changing risk perceptions to influence the currency risk premium. We consider this limitation to be the major cause for the unsatisfactory performance of the earlier currency pricing tests in the literature.

risk may vary over time. Consequently, our results may understate the importance of the currency risk factor if, indeed, currency exposure is not constant over time.

To gain additional insight about the nature of currency risk in Japan, we consider an alternative estimation procedure that relies on time-varying asset pricing exposures. This is a modified version of the asset pricing model of Dumas and Solnik (1995) that builds on the same set of assumptions. Specifically, we assume that risk premiums and an intercept are time-varying conditioned on an information set, Z, available to investors at t−1. Further, we assume that risk premiums and the constant are linearly related to the information instruments. Hence, the Dumas and Solnik (1995) procedure, based on the four factors and instrumental variables described earlier, yields the following pricing error processes

$$u_t = -\boldsymbol{Z}_{t-1}\varphi_0 + \boldsymbol{Z}_{t-1}\varphi_s r_{s,t} + \boldsymbol{Z}_{t-1}\varphi_{vg,t}\, r_{vg,t} + \boldsymbol{Z}_{t-1}\varphi_{sl,t}\, r_{sl,t} + \boldsymbol{Z}_{t-1}\varphi_{m,t}\, r_{m,t} \text{ and}$$
$$h_{it} = r_{it} - r_{it}u_t, \text{ for i} = 1, \ldots, \text{nth portfolio}$$

where h_{it} is the innovation obtained from the first order conditions of their model. The expected value of the innovations, conditional on the instrumental variables (i.e., information set), is zero. Hansen's (1982) generalized method of moments minimizes the average deviation from the moment condition, $\delta_t Z_{t-1} = 0$. Using the GMM method, we estimate the above set of equations and obtain estimates of the coefficients, $\varphi_{k,j,}$ where $k = 0$, s, vg, sl, m and j = constant, IP, UI, UTS, MS, UJS, XM and lagged macro-factor.[28] The coefficients are obtained by minimizing the average deviation from the moment condition defined above.

Multistage Analysis of Instruments and the Risk Factors

Before we proceed with the pricing tests, we perform preliminary analysis of the data. First, we estimate the correlation between the instrumental variables and risk factors. The correlations range from -0.24 to 0.36.[29] The low correlation satisfies the factor orthogonality condition required for the estimation of the asset pricing model. In addition, we regress each factor on the instrumental variables. These results are reported in Table V. The first column presents time-series means and standard errors for each mimicking portfolio return series. They are designed to show the presence of significant unconditional realized risk

[28] These are the Fama and French (1995) value minus growth (r_{vgt}) and small minus large (r_{slt}) return spreads, while (r_{mt}) is the market rate.
[29] These results are available upon request.

premiums. There is no evidence of unconditional premiums for exposure to any of the risk factors. The significant average return on all four mimicking portfolios with no risk exposure implies missing information, model mispecification, or measurement error in proxying the risk free rate.

The rest of the Table V lists results of regressions of the mimicking portfolio returns on the lagged instrumental variables. The instrumental variables are used to detect the presence of time-varying risk premiums. The results suggest that such premiums are significant. The chi-squared tests imply that the lagged instrumental variables have forecast power over all four risk factors. The evidence also shows that there is no significant forecast power over the portfolio representing no risk exposure. The significant regression coefficients of the lagged information variables are inconsistent with the view of no unconditional risk premiums. This implies that some risk premiums can be determined only if time variation is permitted.

Conditional Currency Pricing Tests

Table VI reports the GMM estimates of the four-factor model. The J-test, indicates that the conditional model is not rejected by the over-identifying restriction test. The test statistic is 84.6 with a p-value of 0.32. This implies that the four-factor conditional model describes the data well. Table VI also shows the relation between the risk factors and the instrumental variables. For instance, increases in industrial production have a positive effect on the foreign value of yen and the stock market. However, yen depreciations and stock market declines occur with unexpected increases in inflation. Term structure changes are positively associated with the financial distress (i.e., book-to-market) and size factors. The U.S.-Japanese short-term interest rate spread is positively related with the currency factor. In contrast with Amihud (1993) and Bartov and Bodnar (1994), the evidence also suggests that lagged exchange rates do not have any significant predictive power of future stock returns. This result lends further support to our earlier finding that lagged exchange rate changes have no discernable effects on firm value.

It is interesting to note that the instrumental variables, with the exception of the lagged exchange rate changes, used in the estimation of the conditional model have at least one significant influence on the time-varying expected portfolio returns.[30] Consistent with our unconditional tests, these results suggest that the instrumental variables used in this study have a significant relation with

[30] Using industry portfolios we obtain qualitatively similar results. These results are not reported here, to conserve space, but available upon request. We have also experimented with the world market factor using the Morgan Stanley world market index. While we are able to confirm results reported in Table VIII, the world market factor is found to be insignificant at any conventional level. This result corroborates the evidence (Harvey (1991)) that the stock market of Japan is not integrated with the rest of the world capital markets. Hence, our results remain robust despite the market measure used.

Table 5: Unconditional and Conditional Risk Premiums

Time-Series regression of Estimated ex-post Risk premiums Series of Lagged ex-ante information Variables: 1975–1995

Estimated ex post Risk Premiums for exposures	Time-series Mean (Standard Error)	Constant	IP	UI	UTS	MS	UJS	XM	r_i	Adj R^2	DW	Chi-square Test (p-value)[1]
r_{st}	0.0022	–0.0205	–0.0783	0.0048	0.0063	0.2740	2.0037	0.2810	–0.1845	0.145	2.017	3.59 (0.0121)
	(0.004)	(0.082)	(0.241)	(0.145)	(0.045)	(0.067)	(0.784)	(1.122)	(0.467)			[3.77 (0.864)]
r_{vgt}	0.0037	0.0426	0.0621	0.4043	0.0180	0.0719	0.2701	0.0680	0.0792	0.071	2.102	14.20 (0.031)
	(0.008)	(0.028)	(0.032)	(0.750)	(0.013)	(0.244)	(0.110)	(0.428)	(0.284)			[4.82 (0.122)]
r_{slt}	0.0054	0.0067	0.0337	0.0127	0.0328	–0.1285	–0.5280	–0.0827	–0.4360	0.083	2.041	15.02 (0.004)
	(0.012)	(0.031)	(0.105)	(0.064)	(0.157)	(0.653)	(0.214)	(0.043)	(0.138)			[5.99 (0.045)]
r_{mt}	0.0163	–0.0327	–0.0549	–0.0845	–0.0149	–0.0947	–0.2844	0.0748	0.8240	0.065	2.110	17.26 (0.003)
	(0.042)	(0.062)	(0.216)	(0.266)	(0.043)	(0.042)	(0.180)	(0.135)	(0.350)			[3.45 (0.120)]
None of the factors	0.0363	0.0742	0.0880	0.0139	1.0225	0.5830	3.774	1.004	–0.2785	0.008	2.017	4.55 (0.375)
	(0.0015)	(0.081)	(1.040)	(0.201)	(0.849	(0.415)	(4.031)	(0.964)	(0.550)			[1.060 (0.472)]

[1] Chi-square Test (p-value) of slopes jointly equal to zero with F-Test (p-values) in brackets.
Realized risk premiums are estimated with the slope coefficients of cross sectional regressions of individual stock returns on risk exposures estimated at the first stage. Unconditional significance of risk premiums is assessed with the significance of the time-series mean. Conditional significance of the risk premium is assessed with time-series regressions on the lagged instrumental variables. The standard errors are Newey-West adjusted for heteroskedasticity and serial correlation

Table 6: Conditional Currency Pricing Effects on Japanese Stocl Returns

This table reports GMM estimates of the pricing coefficients of the four risk factors (exchange-rate = s, book-to-market = vg, size = sl and market = m) using monthly excess return data on the MNC, high exporting, low exporting and domestic portfolios. Wald-test statistics: (1)-tests the null hypothesis that all coefficients in the column are equal to zero; (2)-tests the null hypothesis that all coefficients in the column except the $\varphi_{k,\ constant}$ are equal to zero; (3)-tests the null hypothesis that $\varphi_{k,\ constant} = \varphi_{k,\ IP} = \varphi_{k,\ UI} = \varphi_{k,\ UTS} = \varphi_{k,\ MS} = \varphi_{k,\ UJS} = \varphi_{k,\ XM} = \varphi_{k,\ i-1} = 0$ for all k. J-test is the over-identifying restriction test that is χ^2 distributed. * and ** denote significance at the 10% and 5% level. T statistics are reported in parentheses while p-values in brackets.

$\gamma_k = \varphi_{k,\ constant} = \varphi_{k,\ IP} = \varphi_{k,\ UI} = \varphi_{k,\ UTS} = \varphi_{k,\ MS} = \varphi_{k,\ UJS} = \varphi_{k,\ XM} = \varphi_{k,\ i-1}$

Panel A: Bilateral (BXR) exchange rate (1975–1995)

	γ_o	γ_s	γ_{vg}	γ_{sl}	γ_m
$\varphi_{k,\ constant}$	0.0025	0.0217	0.0065	0.0043	0.0462
	(0.472)	(0.169)	(0.382)	(0.482)	(0.741)
$\varphi_{k,\ IP}$	0.0116	−0.0148	0.0110	0.0640	0.0356*
	(1.172)	(1.915)	(0.026)	(0.055)	(1.990)
$\varphi_{k,\ UI}$	0.0395*	0.0362*	−0.0163	−0.0043	−0.1281**
	(1.974)	(2.001)	(0.082)	(0.058)	(2.635)
$\varphi_{k,\ UTS}$	0.0064	−0.0065	0.0019*	0.0110*	−0.0203
	(1.005)	(1.118)	(2.053)	(1.974)	(1.003)
$\varphi_{k,\ MS}$	0.0410	0.0184*	−0.0071	0.0159	0.3610*
	(0.608)	(1.960)	(1.556)	(0.643)	(1.947)
$\varphi_{k,\ UJS}$	0.0731	0.0436*	0.0180	0.0630	−0.1574*
	(0.511)	(2.012)	(0.044)	(0.015)	(1.973)
$\varphi_{k,\ XM}$	0.0058	0.0081	0.0004	0.0117	−0.0549
	(0.027)	(0.014)	(0.011)	(0.072)	(1.664)
$\varphi_{k,\ i-1}$	0.0291*	−0.0083	0.0095	0.0102	0.0074
	(1.956)	(1.478)	(0.577)	(0.996)	(1.447)
	$k=0$	$k=s$	$k=vg$	$k=sl$	$k=m$

Null: $\varphi_{k,\ constant} = \varphi_{k,\ IP} = \varphi_{k,\ UI} = \varphi_{k,\ UTS} = \varphi_{k,\ MS} = \varphi_{k,\ UJS} = \varphi_{k,\ XM} = \varphi_{k,\ i-1} = 0$

1.Wald-test	6.23	4832.01	38.42	27.09	16.47
(All)	[0.48]	[0.00]	[0.00]	[0.01]	[0.03]

Null: $\varphi_{k,\ IP} = \varphi_{k,\ UI} = \varphi_{k,\ UTS} = \varphi_{k,\ MS} = \varphi_{k,\ UJS} = \varphi_{k,\ XM} = \varphi_{k,\ i-1} = 0$

2.Wald-test	5.78	455.92	26.12	21.28	12.55
(Time-invariant)	[0.34]	[0.00]	[0.00]	[0.02]	[0.00]

Null: $\varphi_{k,\ constant} = \varphi_{k,\ IP} = \varphi_{k,\ UI} = \varphi_{k,\ UTS} = \varphi_{k,\ MS} = \varphi_{k,\ UJS} = \varphi_{k,\ XM} = \varphi_{k,\ i-1} = 0$ for all k

3.Wald-test	5103.6
(Cond)	[0.00]
J-test	84.6
p-value	[0.32]

Panel B: Multilateral (TWXR) exchange rate (1978–1995)

	γ_o	γ_s	γ_{vg}	γ_{sl}	γ_m
$\varphi_{k,\ constant}$	−0.0042	0.0310	0.0053	0.0058	0.2561
	(0.212)	(0.338)	(0.180)	(0.401)	(0.219)
$\varphi_{k,\ IP}$	0.0101	−0.0140*	.0092	0.0491	0.0217*
	(1.172)	(1.877)	(0.033)	(0.089)	(1.964)
$\varphi_{k,\ UI}$	0.0502	0.0442*	−0.0218	−0.0121	−0.2205**
	(1.024)	(2.112)	(0.104)	(0.073)	(2.538)
$\varphi_{k,\ UTS}$	0.0114	−0.0047	0.0052*	0.0102*	−0.0104
	(1.093)	(1.105)	(1.903)	(1.838)	(0.718)
$\varphi_{k,\ MS}$	0.0221	0.0340*	−0.0510	0.0135	0.2140*
	(0.725)	(1.985)	(1.625)	(0.705)	(1.953)
$\varphi_{k,\ UJS}$	0.0580	0.0355*	0.0173	0.0412	−0.1102
	(0.601)	(1.960)	(0.070)	(0.053)	(1.327)
$\varphi_{k,\ XM}$	0.0032	0.0040	0.0015	0.0104	−0.0437
	(0.044)	(0.038)	(0.020)	(0.099)	(1.407)
$\varphi_{k,\ i-1}$	0.0328*	−0.0047	0.0077	0.0083	0.0056
	(2.006)	(1.364)	(0.469)	(0.658)	(1.385)
	$k = 0$	$k = s$	$k = vg$	$k = sl$	$k = m$

Null: $\varphi_{k,\ constant} = \varphi_{k,\ IP} = \varphi_{k,\ UI} = \varphi_{k,\ UTS} = \varphi_{k,\ MS} = \varphi_{k,\ UJS} = \varphi_{k,\ XM} = \varphi_{k,\ i-1} = 0$

1.Wald-test	4.10	3802.71	25.20	19.14	18.35
(All)	[0.39]	[0.00]	[0.00]	[0.00]	[0.00]

Null: $\varphi_{k,\ IP} = \varphi_{k,\ UI} = \varphi_{k,\ UTS} = \varphi_{k,\ MS} = \varphi_{k,\ UJS} = \varphi_{k,\ XM} = \varphi_{k,\ i-1} = 0$

2.Wald-test	4.43	251.04	20.73	17.56	16.69
(Time-invariant)	[0.41]	[0.00]	[0.00]	[0.00]	[0.06]

Null: $\varphi_{k,\ constant} = \varphi_{k,\ IP} = \varphi_{k,\ UI} = \varphi_{k,\ UTS} = \varphi_{k,\ MS} = \varphi_{k,\ UJS} = \varphi_{k,\ XM} = \varphi_{k,\ i-1} = 0$ for all k

3.Wald-test	3012.0
(Cond)	[0.00]
J-test	102.3
p-value	[0.59]

the four risk factors in the context of the conditional asset pricing model as well. We have also tested various restrictions using the Wald test to examine whether the null hypothesis that all $\varphi_{k,j}$ coefficients of instrumental variables are zero with respect to a specific risk factor *k*. The Wald test rejects the null that all coefficients of the currency-risk factor are zero at the 1% level. As shown in Panel B, the evidence suggests that this result is not sensitive to the currency-risk measure. The coefficients of the currency-risk factor, using the trade-weighted exchange rate, are found to be statistically different from zero at the 1% level. In the second Wald test, we restrict all $\varphi_{k,j}$ coefficients to be equal to zero while the constant is allowed to be time-invariant. Once again, the results reject the null hypothesis. Both bilateral and multilateral (trade-weighted) currency risk factors are found statistically significant at conventional levels. Finally, we test the null hypothesis that all $\varphi_{k,j}$ coefficients are equal to zero for all *k* factors. This hypothesis is also rejected at the 1% level. These results are consistent with those reported by Dumas and Solnik (1995) and De Santis and Gerard (1998), at the aggregate level, supporting the view that currency risk is of hedging concern to investors and priced by the market. While also consistent with our unconditional findings, they provide corroborating evidence in support of the view that currency exposure is time varying. Furthermore, the conditional asset pricing tests support a four-factor asset pricing model. Hence, currency risk, relative distress and size factors appear to covary with stock returns beyond the covariation explained by the market return in Japan.

VI. CONCLUSIONS

This paper examines the exposure of 1,079 Japanese firms traded on the Tokyo Stock Exchange over the 1975–1995 period and 25 industries to movements in the foreign value of the yen using unconditional and conditional testing procedures. These tests are similar to the recent conditional framework used in aggregate currency pricing tests that rely on the assumption that the currency risk premium is time-varying in response to changes in business conditions and investors' perceptions of risk. In contrast to previous work, focused primarily on U.S. firms, our results identify a reliable relation between contemporaneous stock returns and unanticipated yen fluctuations. This relation appears to be stronger for MNCs and firms with higher foreign economic linkages compared to firms with low foreign involvement or without any direct foreign economic ties. Unlike the empirical evidence of U.S. studies, we show that Japanese firms are more sensitive to foreign exchange-rate fluctuations and that foreign currency risk is a priced factor in the Japanese equity market. Furthermore, our empirical evidence fails to support the view of lagged exchange-rate effects on firm value. Lagged-exchange rate changes are also found to have no predictive power for future stock returns in the context of asset pricing tests. These findings imply that Japanese investors use all available information impounded in current exchange-rate changes to predict changes in firm value.

The evidence also shows that currency exposure varies across time. Exchange-rate exposure is found to be different during the 1975–1985 period, compared to the post-1985 period. This result appears to consistent with the greater use and availability of financial derivatives for managing corporate exchange-rate risk during the last ten years. More specifically, exchange-rate exposure is reported to be inversely related to the firm's size and debt to asset ratio. Consistent with the recent evidence on the hedging activities of U.S. firms, this result suggests that the use of financial hedging derivatives rises proportionately with the size of the firm. In addition, use of currency derivatives has a negative impact on the firm's foreign currency exposure.

The time-varying nature of currency exposure suggests that the currency pricing results are likely to be sensitive to the type of asset pricing model used. To shed more light on the currency exposure of the firm, we use conditional asset pricing testing procedures to determine whether currency risk is priced. Conditional currency pricing tests show that currency risk is priced in the Japanese capital market regardless of time period and currency measure. In contrast to the evidence from U.S. studies, our results indicate that Japanese investors require compensation for bearing foreign currency risk. Consistent with findings of recent studies (Dumas and Solnik (1995) and DeSantis and Gerard (1998)) which report that currency risk is priced at the aggregate level in international capital markets, our evidence shows that conditional reward to covariability ratios associated with the currency and market factors are significant at the firm and industry level in Japan.

Consistent with the recent work of Fama and French (1996) for U.S. stocks, our analysis shows that there is significant covariation in Japanese stock returns with the relative distress (value minus growth return spread) and size (small minus large return spread) factors. In brief, our results favor the existence of a multi factor equilibrium asset pricing model that is consistent with a four-factor version of Merton's (1973) intertemporal capital asset pricing model or Ross' (1976) arbitrage pricing theory that recognizes investors' sensitivity to exchange-rate risk along with the market, financial distress, and size risk factors in Japan. Whether these results also apply to the pricing of exchange-rate risk and the other three risk factors in other stock markets remains an open question, which is left for future research.

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